URGENT SURGERY

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BY

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TRANSLATED FROM THE SIXTH FRENCH EDITION BY

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WITH 20 FULL-PAGE PLATES AND 994 ILLUSTRATIONS

OF WHICH 602 ARE DRAWN BY DR. E. DALEINE AND A. LEUBA, AND 217 ARE FROM ORIGINAL PHOTOGRAPHS

VOL. I

INTRODUCTORY—HEAD—NECK—CHEST—SPINE—ABDOMEN

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AUTHOR'S PREFACE

URGENT surgery does not mean merely the surgery of injuries ; at the present day the number of clinical conditions demanding immediate surgical action is very great. Step by step, as operative results have improved, the indications of urgency have extended and multiplied ; we are better equipped than formerly, and our responsibilities have thus enormously increased.

The surgical spirit belongs to all times ; in all ages, conscientious and energetic men have rebelled against the theory of *laisser faire* and *laisser mourir*. Have not our predecessors dimly foreseen, devised, and tried many of the operations which are in general use to-day ? Our own horizon has cleared ; we see further, and our surgical initiative is freed from its early fetters. That, however, is not enough ; ere modern surgery can fulfil its promises and play its proper part, its formulæ and precepts must be generalized ; and they must be introduced into the everyday work, the spirit, and customs of the profession.

It is time to sweep away that ill-omened duality, that inexplicable antithesis of doctrine and practice : doctrine, rejuvenated, scientific, positive ; practice, governed only too often by the errors and empiricisms of other days.

This it is indeed which occasions difficulties and obstacles, so much more numerous and disconcerting because the indications of urgency may present themselves in any circle, at any time, and in any hands.

The problem is complex ; and here we wish to emphasize only one factor—to our mind the most important—for its solution : the determination to know what should be done, and the desire to do it. These are the conditions necessary for beneficial action.

At the present day, in the majority of urgent situations duty is clear, and the indications for action are well defined.

Further : in such matters, those who are not operators themselves should at least know something of the details of the operation : the idea of an operation, existing in the mind of the non-operating physician as a vague and distant event to be invoked only as a last and desperate resource, should give place to a clearer conception of the possibilities and limitations of modern surgery.

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Lastly, there are certain things which every practitioner should be able to do, and which he cannot avoid without dereliction of duty ; and though it is true that operative skill is only to be attained by actual practice, it is the more necessary for all practitioners to be conscious of the unavoidable obligations of urgent surgery.

Such are the ideas which have guided me in the conception and execution of this work. I have tried to set forth the indications for, and the technical details of, the principal urgent operations, in an essentially practical manner. Here, then, will be found no theoretical discussions, no complex bibliography, no descriptions of untried methods.

I have given examples, and outlined some clinical pictures, in order to show what ought to be done, and how it ought to be done.

Illustration plays an important part, and the drawings are the work of my friend Dr. Daleine ; we have sought to represent by drawings and photographs most of the manœuvres, the operative steps, and the most indispensable instruments ; we have studied and prepared them together, and I shall never forget this long and intimate collaboration.

This book has cost me much time and trouble. I have written it slowly, and I might say that I have lived it before writing it. I believe and hope that it will render good service.

F. L.

PREFACE TO THE SIXTH EDITION

Several new chapters have been added to this edition, amongst which I may mention those dealing with Mediastinal Abscess, Wounds and Ruptures of the Pancreas, Foreign Bodies in the Stomach, Hæmatocolpos, and Urgent Amputations. Others have been altered or enlarged: the most important changes will be found in the articles on Gunshot Wounds of the Ear, Mastoiditis, Wounds of the Chest, Wounds of the Ureter, Dislocations and Fractures of the Carpus.

The surgery of the extremities, and particularly of dislocations and fractures, has again been carefully revised.

Ninety new figures have been introduced; and the whole book has been extensively remodelled.

These alterations, and the employment of new ideas and new methods, born of daily experience, have been made possible by the repeated editions. All urgent operations and procedures are described, but it is certainly not intended that they should all be attempted by any one, and in any surroundings; but "even those who are not operators should be familiar with the details of the operation," and, possessing such definite knowledge, they will be the better able to grasp and formulate the indications in any urgent situation.

F. L.

March, 1909.

TRANSLATOR'S PREFACE

SINCE its first appearance in 1899, six editions of Dr. Lejars' work have been published in France, and it has been translated into German, Spanish, Italian, Hungarian, Russian, and Japanese.

These facts sufficiently indicate the great practical value of the book. I believe it will prove as useful in this country as elsewhere.

Although primarily intended for those practitioners who have only occasionally to face urgent situations, I hope that it will be of interest to others who do not need its help, from the fact that the translation, not being in any way "edited," gives a true picture of French technical methods, and may therefore enable operating surgeons who are unacquainted with the details of Continental practice to compare those methods with our own.

Finally, I desire to express my thanks and sense of deep indebtedness to Mr. E. W. Hey Groves, F.R.C.S., for his great help in the work of proof-reading and for many valuable suggestions.

W. S. D.

November, 1909.

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URGENT SURGERY.

SECTION I. INTRODUCTORY.

THE EQUIPMENT AND THE URGENT OPERATION.

URGENT surgery is done from time to time, and ought to be done, everywhere—in the well-equipped operating-theatre, in the great centres of population, in the wealthy suburbs, in the country, in the cottage, on the field of battle.

I have not insisted here on the equipment and organization of the model operating-theatre, which represents the indispensable complement of a hospital emergency service. Outside the hospital the situation is always more complex and more difficult, and in order to carry out satisfactorily some urgently necessary procedure, a degree of practical knowledge, initiative, and devotion to the patient's welfare is needed, of which hospital surgery gives but an imperfect idea.

This is especially true for the practitioner almost or quite isolated in some little town or in the country, but any operating surgeon may become at some moment thus isolated, dependent on his own resources, and perhaps so much the less able to help himself because he is accustomed to being well served. I have imagined myself placed under such conditions in writing the essentially practical pages which follow.

I. THE EQUIPMENT.

There is an "urgent equipment" which every practitioner should have at hand, carefully preserved and always ready for unexpected eventualities, an "urgent equipment," not costly, nor bulky, and easily carried in the pockets of a carriage, in a bag, or in a towel. Surgery is, in one sense, a handicraft: as such it has its necessary tools. To draw up a complete and unvarying list would be foolish; further, it is not enough to procure antiseptics, anæsthetics, receptacles, and the like: it is equally necessary to know how to preserve and keep them always ready at hand. Does not the urgent operation always come as a surprise? Provided with the following simple equipment, the surprise will never be complete.

There should always be at hand :—

Receptacles : a vessel for boiling water, a fish-kettle of enamelled iron, and three trays (*Figs.* 4 and 5) for the instruments. The boiler and the fish-kettle (not very portable) will be most useful at home : the trays should fit one in the other, and will occupy little space.

Brushes of the pattern shown below (*Fig.* 1), for preparing the hands and the field of operation. These are best kept dry, protected from dust, and should be boiled before using.[1]

An Irrigator is an indispensable article, and one which, in practice, is most often badly sterilized. It consists of a can of enamelled iron, a tube of red indiarubber, and some glass nozzles. Tube and nozzles, wrapped in a compress or a piece of wool, should be kept in the can, and the whole apparatus preserved dry and protected from dust. The can will be flame-sterilized, the tubing and nozzles will be boiled in water or an antiseptic solution for half an hour, or better still, if a vessel sufficiently large is available, the whole apparatus should be boiled. I repeat with emphasis, *the indiarubber tube must be boiled.* Good indiarubber bears boiling perfectly, and in any case, to use a sterilized can and a sterilized nozzle with a dirty tube is folly. Be careful with the nozzles : they may break if thrown into boiling water, or if after sterilizing they are dropped into a cold solution while still very hot. The act of connecting the three parts—can, tube and nozzle—is a common source of mischief. The outside of the can and the tube may be touched with unsterilized hands, the nozzle must remain sterile within and without, and must therefore only be touched with sterile hands or forceps. No tap is necessary, compression of the tube with the fingers or a tube clip being a more satisfactory arrangement.

Fig. 1.—Brushing the nails.

Necessary Liquids :—

Alcohol, 90 per cent.—This is easily preserved in well-corked bottles kept out of the sunlight.

Ether.—Also to be kept out of direct light, and in a cool place, in bottles of moderate size (5 oz.), well corked with an ordinary cork or a ground-glass stopper.

[1] Wood fibre, such as is used for packing, properly boiled, is an excellent scrubbing agent.

Chloroform.—Good chloroform in yellow glass bottles with ground-glass stoppers, of moderate capacity (5 oz.), keeps excellently for years. (*See* ANÆSTHESIA.)

Antiseptics.—In concentrated solution or in tablets; the choice of these can be varied widely, but the following will suffice for all urgent needs:—

One or two bottles of *carbolic acid* in glycerin: pure phenol, 2 oz.; glycerin, 2 oz. The contents of one of these little bottles, poured into 2 or 4 pints of boiled water, will make 2 pints of strong carbolic lotion (1–20), or 4 pints of weak lotion (1–40).

Corrosive Sublimate, in tablet form, tinted with some simple colouring matter to render the recognition of the resulting solution easy, of such strength that one tablet dissolved in a pint of boiled water will make a solution of 1–1000. Instead of, or in addition to, the tablets, a *concentrated solution of sublimate* in rectified spirit may be used, preserved in bottles of

Fig. 2.—Swabs and compresses. They have been boiled or sterilized in an autoclave, enclosed in a compress; they are arranged in sterilized basins, which are covered by the enveloping compresses when these have been untied and spread out.

yellow glass with ground-glass stoppers: sublimate 80 gr.: spirit 90 per cent 4 oz. One tablespoonful of this solution in a pint of boiled water will make the 1–1000 solution commonly used; one tablespoonful in two pints of water will give a solution of 1–2000, and so on; the bottle containing 4 oz. would therefore be sufficient to provide a gallon of solution of the usual strength. For measuring the quantities it will be well to provide a metal spoon sterilized in a spirit flame.[1]

Sterilized Gauze, to make swabs and compresses (*Fig.* 2). Nothing is more indispensable, and it might be added that nothing appears more rarely in the practitioner's ordinary armamentarium. Without speaking even of the "old linen" or of the ordinary cotton wool usually

[1] In urgent practice, a flame-sterilized ladle is often needed for taking boiled water out of a boiler, etc.; to sterilize thoroughly, pour some spirit on a plate or into a basin, and some into the ladle itself; the ladle will thus be "fired" on both surfaces when the spirit is lighted; be careful to "fire" the part of the handle next to the bowl.

preserved in a corner of a cupboard, there is a widespread belief, even amongst those who desire to do their work well, that the cotton wool of commerce, termed by courtesy aseptic, is really so: a packet is opened, the wool is rolled into balls or cut into sheets, and these are the swabs and the compresses. Even if the wool were aseptic it would still be necessary that the cutting up should be done only with properly sterilized hands, without much handling of the material and without touching the edges of the wrapper. Practically, the task is beset with difficulties; moreover, without in the least denying that good brands of cotton wool may really be aseptic when freshly prepared, it is impossible that they remain sterile, often at the end of a very long time, in a wrapper which is not itself sterile and not impermeable. It would always be well to have two or three German silver or tin boxes filled with sterilized gauze compresses, of a conveniently portable size, hermetically sealed, in which the contents could be trusted to remain sterile indefinitely. If not, it is at least necessary to have a packet of *soft undressed gauze*, rolled and well wrapped up, and a packet of linen.

With this gauze and linen excellent compresses can be made, which will meet all the needs of an operation and the dressing; they can be cut and boiled when occasion arises, but it is better to have a certain quantity prepared in advance.

The linen should be cut into squares measuring about 16–20 in., intended for placing around the area of operation. It is convenient to cut the gauze in two sizes: the larger, 8–10 in. square, of four thicknesses, roughly stitched together at the edges, will serve for protecting and for packing into the wound; the other and smaller pieces, crumpled up for sponging; or again, you may make the swabs out of balls of cotton wool enveloped in gauze.

Furnished with three packets of compresses and one packet of swabs, the practitioner will have at hand all that he needs to be prepared for any emergency. It will suffice, as we shall see presently, to boil the compresses and swabs for half an hour in plain water, or better, in water to which a little bicarbonate of soda has been added.

Ligatures and Sutures.—Here again it will be an excellent precaution, if possible, to have a stock of reliable materials, sterilized and safely stored, provided that the gaps in the stock are filled up as they occur. It is well to have catgut, silk, and silkworm gut: the catgut and the silk in various sizes. If, however, catgut properly prepared and sterilized beforehand is not available, it will be better to dispense with that material, its sterilization taking too long and being too troublesome for the practitioner who has only occasional need for it. The preparation of silk and silkworm gut is, however, quite simple and always possible.

Keep your bobbins of silk and your hanks of silkworm gut in a little metal box: that will take up very little room. Before each operation, take the quantity necessary and boil it in water for an hour. In private practice, which we have in view, where operations are not frequent, this is the surest and most economical plan. We may add that silk alone will

meet every requirement for ligatures and sutures, and in case of need, ordinary linen thread, carefully boiled, will be perfectly satisfactory.

Do not forget to provide different sizes of silk, heavy, medium and fine (o and oo); the fine numbers are often lacking in a private equipment, though they are almost indispensable for satisfactory suture of intestine, bladder, etc., possibilities by no means uncommon in urgent surgery.

It is also necessary to have a stock of silver and aluminium-bronze wires.

Drainage Tubing, of different sizes. This is best kept dry, protected from dust in a glass tube or, better, in a metal box, and will be boiled for half an hour before being used.

Dressings, of gauze tissue and ordinary cotton wool: wide bandages of dressed muslin, gauze, and crêpe; and safety pins.

Soft Rubber Catheters, of good red rubber, some gum-elastic catheters, some fine bougies, some olivary bougies: all kept dry in a metal box.

The practical sterilization of catheters and bougies is a difficult matter. For the soft red-rubber catheters—the most useful type in urgent surgery—boiling is the best and simplest method. (*See* URGENT CATHETERIZATION.)

A Packet of Starched Muslin, for making bandages and plaster apparatus. (*See* TREATMENT OF FRACTURES).

Plaster of Paris, which may be kept in wide-mouthed bottles, well corked and sealed, or better (bottles being breakable) in a tin with a tight-fitting lid, and protected from damp.

The perusal of this list may give the impression that it deals with a large and cumbrous outfit. That is not the case: a simple recapitulation will show that, reduced to the strict minimum, it will occupy very little space:—

Two boilers and a fish-kettle of enamelled iron; three earthenware trays; two nail-brushes; an irrigator of enamelled iron, with red rubber tubing and glass nozzles; a bottle of rectified spirit, one of ether, three of chloroform, two small bottles of carbolic acid, another containing tablets of corrosive sublimate; three boxes of compresses and one of swabs; a little box for silk and silkworm gut; a long narrow box for drainage tubing and catheters; a packet of starched muslin; a tin of plaster of Paris.

Of course, this equipment will be useless in some places, but it will always be valuable in a number of cases where immediate action is necessary to ensure success; and finally, it is ample for dealing with most conditions of extreme urgency.

Instruments.—Here I wish to speak only of the "tools" of general necessity; à propos of each operation I shall indicate the special

instruments which are useful. Those which are here described are indispensable to every medical practitioner who is liable to the demands of urgent surgery.

It is not enough, however, to be furnished with tools: it is essential that they shall always be ready for use. To preserve intact, clean, and ready for employment at a moment's notice the instruments which perhaps he uses only at very long intervals presents a great danger and a great practical difficulty to the isolated practitioner. I have seen, in the hands of educated men, tools with the condition of which no competent workman would have been satisfied. There is so little surgery, says one; but nevertheless, wherever you are, and at any moment, you may be called upon to do a tracheotomy, or a tapping, to open an abscess, to deal with diffuse suppuration or infiltration of urine, to suture a wound, to set a complicated fracture, or perhaps to perform an amputation.

Again I refrain from drawing up a hard and fast list, and simply say that possessing the following instruments you will be in a position to face almost any condition of immediate urgency.

A good aspirator and a *thermo-cautery* ought to be in the hands of every practitioner; also an *indiarubber bandage*,[1] a pair of *tongue forceps* (*see Figs.* 30 and 31), three metal *tracheotomy tubes* (Nos. 18, 20, and 24), and a stomach tube of red rubber with a large funnel.

Cutting Instruments.—Several *knives* with fixed blades,[2] straight—three at least—an ordinary scalpel, a narrow bistoury, a probe-pointed bistoury[3]—two pairs of ordinary *scissors*, straight and curved, one pair of long and strong scissors, two *amputation knives*—a 4-inch and a 6-inch,[4] a large saw with movable back, and a pair of Liston's *bone forceps*, angled on the flat.

These edged tools should be the objects of special care; after being used they should always be dried as soon as possible, after which they should be lightly smeared with vaseline.[5] Alcohol, chloroform, or petrol may be used with advantage to insure perfect dryness.

To continue my list: two grooved *directors*, one grooved to the tip and one probe-pointed; one pair of ordinary *dissecting forceps*, another with teeth; two double-ended *retractors*, and some pairs of *pressure-*

[1] Or Esmarch's apparatus, a rubber bandage and a heavy rubber tube, may be substituted. Unfortunately, like all rubber articles, this apparatus deteriorates if it remains long unused, and may be useless when needed. A long and strong rubber bandage will render almost the same services, and further is useful for many other purposes (compression of joints, reduction of dislocations).

[2] All folding instruments should be rigorously excluded; it is difficult enough, especially under the conditions we have laid down, to disinfect the instruments and keep them clean, without complicating the problem further by multiplying hinges and joints.

[3] This is, be it understood, a strict minimum, especially if the practitioner is unable to sharpen his own knives. For Cooper's hernia knife, see HERNIA.

[4] The enormous amputation knives which figure in the majority of catalogues are not at all necessary; any amputation can be done with an ordinary scalpel, if needs be; the two knives indicated above are amply sufficient.

[5] Quite a good plan is to keep the scalpels in a glass tube filled with chloroform and well corked.

forceps. The scalpel, the scissors, and the pressure-forceps are the instruments which nothing can replace. Do not be afraid of having too many forceps—twelve to eighteen pairs at least. If possible, it will be well to complete the series with half-a-dozen pairs of Kocher's forceps (*Fig.* 3). Well handled, the ordinary pressure-forceps will suffice for the control of any bleeding that can be dealt with by means of forceps; nevertheless two small curved clamps and a long straight one will have their field of usefulness.

Let us include also an *aneurysm needle*, one or two pairs of *vulsellum forceps*, a long double-curved *curette;* and two "tools" very useful in urgent bone surgery, the curved *periosteal elevator* and the *gouge-forceps*.

Suturing Instruments of various kinds. These may be very simple. *Reverdin's needle* lends itself to all types of suture and facilitates the task for unpractised hands; it will reappear frequently in our illustrations. But it demands the most careful attention, otherwise it gets foul and stiff, and too often it happens that it only serves once. It will not do simply to wash and dry the instrument after use; it must be taken to pieces, the two segments carefully cleansed with absolute alcohol or chloroform, dried, and the movable portion lightly vaselined before it is put together again: simple precautions indeed, taking little time, but which in practice are generally neglected. Some other needles in handles, with open or closed eyes, require less attention. (*See* WOUNDS OF THE SOFT TISSUES.)

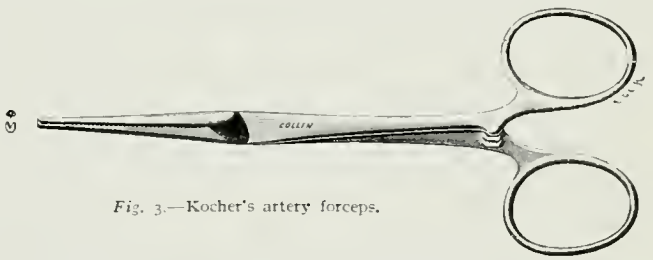

Fig. 3.—Kocher's artery forceps.

Finally, *ordinary curved suture needles*, mounted on a needle-holder, or held with a pair of pressure-forceps or simply in the fingers, will render excellent service, and may suffice, after some practice, for every need. (*See* INTESTINAL SUTURES.)

Such is, in short, the necessary armamentarium. It is convenient to divide these instruments into two groups: the first, comprising those in most frequent use—an ordinary scalpel, the scissors, the directors, dissecting forceps, and some pairs of pressure-forceps—will be placed in the little metal box which is to serve as the case; the remaining instruments, less often needed, will be kept in one or two larger metal boxes, or may be laid out side by side in a dry, well-fitting drawer.

How are they to be cleaned? Common place details, but details of the greatest importance. No good can be done with a blunt knife, with scissors which do not cut, or forceps with rusty jaws, and any time devoted to their care will never be time lost. A simple procedure consists in washing and brushing the instruments in cold soapy water, then rubbing them well with

a piece of linen soaked in alcohol or petrol, after first taking to pieces the forceps and scissors, paying special attention to any stains on the jaws and around the joints, etc. Finally, polish well with a clean dry towel. If they are badly soiled, and cleaning has been delayed, it is useful to immerse them first of all in a weak solution of potash; after that they are brushed, as before, in cold soapy water, then rubbed with alcohol, and dried. If any stain or tarnished point still persists, rub it with a chamois leather. This is no very complicated task. I know of others, willingly undertaken in the name of sport, which are less useful and far more troublesome.

II.—A CASE OF EXTREME URGENCY, WITH COMPLETE LACK OF NECESSARIES.

No one will question the wisdom, when possible, of postponing such an operation for sufficient time to procure a conventional equipment, but circumstances arise when immediate intervention is demanded, far from all resources, perhaps at night. It has happened to me to find myself with a single colleague, who took charge of the chloroform, in the country at night, face to face with operations of imperative urgency, and I can recall cystotomies, operations for strangulated hernia, and amputations performed under such circumstances. What else can be done? To put off the operation till the morrow means death; to renounce proper surgical precautions, declaring them impossible of realization, again is death. But even under such desperate conditions, with sufficient tenacity of purpose, the majority of urgent operations can be carried to a satisfactory ending. Everywhere you will find *fire*, *water*, and *linen*; I may add also *salt*, and often baking soda. With these the instruments, the dressings, the operator's hands, and the patient's skin can all be sterilized quite satisfactorily. But it is necessary to have the determination to carry out the task in its entirety, and also to work with method, in order to work quickly.

Here is, to my mind, the best plan of action:—

1st Stage.—Have a fire lighted. Have all the usable vessels brought to you: tin pots, coppers, saucepans, which will serve as boilers; basins, bowls, and plates, which, boiled or flame-sterilized, will receive the instruments, compresses, and ligatures.

Inspect the available linen—not the rags laden with dust which are in many households dignified by the name of "dressing linen," but the handkerchiefs, napkins, and towels, recently washed and ironed; the handkerchiefs will make excellent compresses, the napkins and towels may be cut in two or four, or preserved entire to surround the field of operation. Of course, if you find any muslin or gauze you will give it the preference.

If there is any spirit—methylated or drinkable—in the house, put it aside for flame-sterilizing any vessels too large to be boiled. Perhaps you may also find some antiseptic solutions; if the bottles have not been opened,

you may reserve them for use, but if they are already uncorked and partly empty they should be rejected without hesitation.

Have **three vessels** placed on the fire : one for the instruments, the sutures, and the ligatures, to which you may add, wrapped up in a compress, the brushes, and the glass nozzles of the irrigator ; another for the compresses and swabs, and also the drainage tubes, a soft rubber catheter, and the tube of the irrigator ; a third for boiled water. If a large copper is available the basins and irrigator should be boiled in it.

Boiling for from half to three-quarters of an hour in ordinary tap-water will suffice. If, however, you have salt or bicarbonate of soda at your disposal so much the better ; the compresses will then be boiled in a 1 per cent solution of common salt, and the instruments in a 1 per cent solution of bicarbonate of soda[1] for half an hour. Practically this works out as follows :—

Into one of the vessels, two-thirds filled with water, throw some cooking salt—roughly about a teaspoonful to the pint—let it dissolve, then introduce your compresses, bundled up in a towel in such a manner that they may be withdrawn *en bloc* (*see Fig.* 5). Into the other throw a teaspoonful of baking soda to the pint of water, but await boiling before dropping in the instruments, which tarnish and become covered with black spots when immersed in slowly heating water.

I repeat that the *boiling ought to last for half-an-hour at least*, and by that I mean true boiling. During that time you will turn your attention to other preparations.

2nd Stage.—**Prepare the operating-room, the operating-table, the patient.** If you have a choice, take the best lighted, best warmed, and least furnished room. If at night, get all the lights you can : there never can be too many if they are well placed. I remember an operation for strangulated hernia performed at night in a little room in a distant quarter of Paris, in the midst of a veritable illumination. All the lamps in the building had been collected for the operation ; I have never been so well lighted in hospital. Do not move the furniture more than is necessary for placing the operation-table and two small tables, and to have room to " turn round." Nothing is more irrational than the turmoil which is sometimes seen on these occasions : curtains are pulled down, furniture is pushed about, the floor is brushed, and the dust, accumulated during months, is stirred up. It is much better simply to have the floor sprinkled with water or wiped with a damp cloth.[2]

A kitchen table or two planks on trestles with a hard mattress will serve for an operating-table. It is rarely necessary to operate on a patient in bed. The mattress will be covered with a mackintosh, that again with a

[1] Salt solution damages the instruments. A solution of benzoate of soda may also be employed, or, best of all, one of borate of soda (borax), in the same strength (1 per cent), and it would be a wise precaution always to be provided with a supply of the latter salt. A 2 per cent solution of borax boils at 106° C., the same solution of baking soda at 104·6° C.

[2] Of course, if there are some hours to spare, it is advisable to clear the room completely, to have the floor washed and the walls sprayed; then the operating and side tables having been installed, the door will be locked until the time of the operation.

a blanket and sheet, and a pail or other suitable, but perfectly clean, receptacle placed on the floor at the foot of the table. Two small tables will be placed, one on either side of the operating-table; that on the side of the assistant will carry the basins for the compresses, swabs, and ligatures; the other, on the side of the operator, the trays for the instruments.

Return to your patient: have the operation area shaved if necessary, and if the operation is likely to be long and serious, envelop the lower extremities with long stockings of cotton wool or flannel.

3rd Stage. — Wait until everything has boiled for a sufficient time, then remove your vessels from the fire, let them cool, and have them conveyed to the room where you are going to operate.

Now is the time, if you have not been able to boil them, for *flame-sterilizing* the basins and trays. Flame-sterilization should never be the method of choice: to be adequate it must be prolonged.[1] Pour in two or three tablespoonfuls of spirit, and light it; then, taking hold of the basin or tray, incline it and turn it in all directions, so that the liquid and the flame may spread over the whole inner surface.

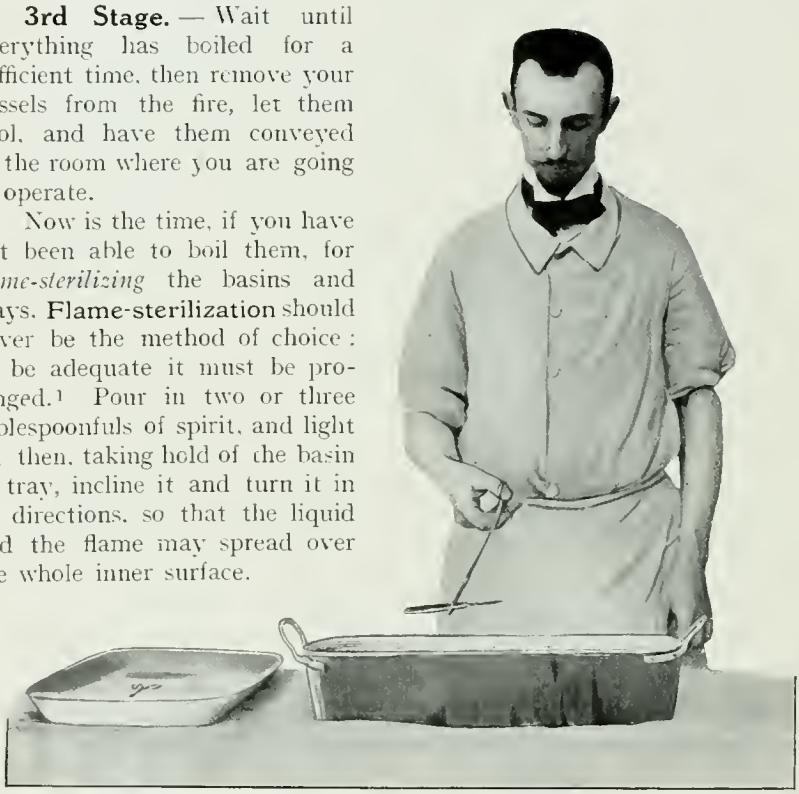

Fig. 4.—The instruments, after boiling, are taken from the fish-kettle with a pair of sterilized forceps and arranged in the sterilized tray.

After that is done, take the instruments and compresses out of the boilers, to do which you must provide yourself with a pair of long forceps which have been flame-sterilized over two-thirds of their length, or which you have boiled with the other instruments, leaving the handles outside of the boiler. With these forceps lift out the boiled instruments, one by one, and arrange them in the trays (*Fig.* 4), placing aside without hesitation any

[1] Three minutes, as a minimum, for enamelled, four minutes for earthenware or china vessels.

which by chance may come in contact with the edges of the vessel. In the conditions with which we are here dealing, it is well as a general rule to prevent any contamination with dust by covering the instruments in the trays with boiled water. With the same pair of forceps lift out the bundles of compresses and swabs, and arrange them in the basins (*Fig.* 5); do not untie or touch them; later, when you have sterilized your hands, you will open and spread out the wrappers (*Fig.* 2).

To lift out the boiled water, provide yourself with a soup ladle or large iron spoon, flame-sterilized or boiled like the forceps. Never pour the water direct from the boiler, since that would involve a risk of contamination from the edge of the vessel.

It will usually be necessary to have in readiness a tray for the instruments, a small tray for the ligatures and sutures, two basins for the compresses and swabs, and two more filled with boiled salt solution for rinsing the hands during the course of the operation.

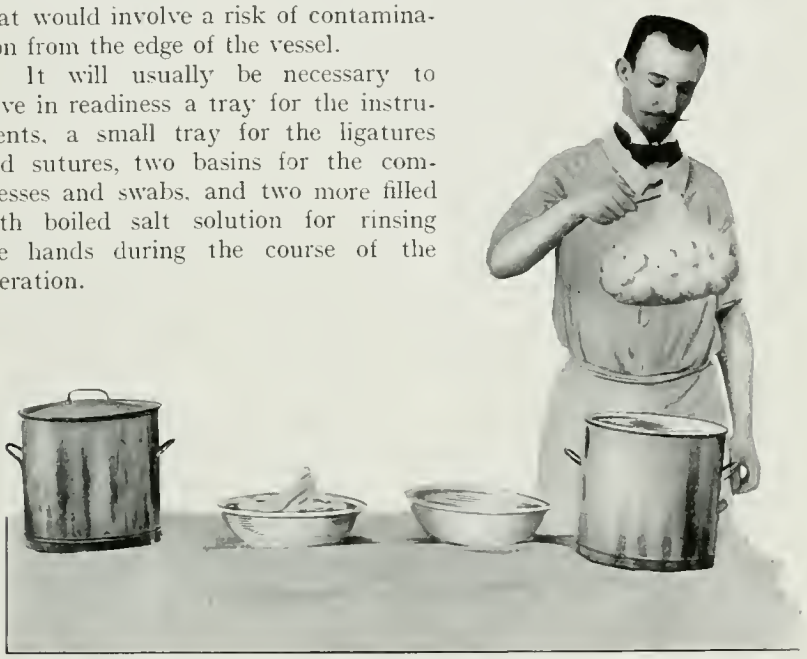

Fig. 5.—The bundles of compresses and swabs are taken out of the boiler and placed in the sterilized basins.

4th Stage.—While the patient is being anæsthetized, sterilize your hands. **Sterilization of the hands** is a science and an art. Further, it is the first duty of the surgeon. It is as devoid of reason to dip the fingers for a few seconds in an antiseptic solution as it is to burn the skin with strong and caustic fluids. *Mechanical cleansing*, that is to say, *brushing and washing with soap and warm boiled water*, is the first and chief step in the sterilization of the hands.[1] Roll your shirt sleeves well up above the

[1] Here I wish to say that every conscientious practitioner, called to operate from time to time, and often to attend confinements, ought always to have some pairs of indiarubber gloves, which he should boil and employ for "dirty cases," opening abscesses, dressing septic wounds, etc. *To use gloves for septic operations, in order to be able to do the aseptic ones without gloves*, is, to my mind, the wisest plan in general practice.

elbows, and fix them there with two pins ; if you have not at your disposal a suitable wash-stand, have a large basin prepared, boiled or flame-sterilized, a large jug of hot water and another of cold boiled water, soap, and a brush (also boiled) ; cut your finger nails short.

It is well to commence the washing in very hot water (as hot as can comfortably be borne), which quickly makes an abundant lather ; immerse both hands entirely in the water, and soap energetically up to the elbows : the skin is soon red and sweating. Then take the brush and brush freely ; brush the palms and the backs of the hands, the spaces between the fingers, under and around the nails (*Fig.* 1). With some practice this somewhat rough cleansing can be carried out without damaging the skin. The brushing in hot soapy water, several times changed, ought to last for at least ten minutes, but there would be no harm in prolonging it still further.

This mechanical cleansing is not sufficient by itself. Two other basins have been sterilized : one contains spirit, 90 per cent ; the other boiled

Fig. 6.—How sterilized basins should be held. Properly, to the left. Wrongly, to the right.

saline solution. After the preliminary washing you bathe your hands successively in the spirit and the saline solution. In this stage, as in the former, you must not be content with simple washing, but must employ prolonged friction, using a boiled compress for the purpose. The spirit is a necessary agent in this method of disinfecting the hands : it acts chiefly by removing the grease from the skin. It can be recognized that the hands are properly prepared when, after withdrawal from the basin of spirit, the surface is uniformly wetted on coming in contact with the saline solution. If the latter liquid does not spread in a continuous film over the skin, but leaves some islets uncovered, you will know that the spirit has not acted sufficiently, and the process must be repeated.[1]

With some care and use, the skin does not suffer from this sterilization,

[1] If the hands have been recently contaminated with septic matter and you must work without gloves, it will be well, after long-continued washing in several changes of soapy water, to wash and brush the hands with a 1–1000 solution of perchloride of mercury in spirit, but it is much better to operate gloved.

even if repeated several times a day, and the surgeon who has thus conscientiously "prepared" his hands—and also knows how to keep them clean by guarding them from any septic contact—may approach his operative task with perfect confidence.

Rinse the hands often during the operation,[1] and see that the solution intended for the purpose is frequently renewed; see also that the assistant charged with looking after the basins takes hold of and carries them between his outspread hands, in contact with the outer surface only, so avoiding contamination of the interior and the contents from his thumbs (*Fig.* 6).

5th Stage.—The patient being anæsthetized: **prepare, or have prepared, the operation area.** If you have an assistant, he will sterilize his hands and proceed to the preparation in the manner about to be detailed; if you are alone, you will first wash your hands well with soap and water, then wash and scrub the operation field; then, before completing the process and taking up the scalpel, you will thoroughly disinfect your hands with soap, spirit, and saline solution.

The preparation of the patient's skin follows the same lines as that of the surgeon's hands. The area is carefully shaved, and washed with hot water, soap, and brush for five minutes; the brush must be used gently, guarding against any abrasion or excoriation of the skin; as mentioned previously, wood fibre, or a loofah properly boiled, will advantageously replace the brush. The extremities and the umbilicus need special care. Further, the washing and brushing should go widely beyond the strict limits of the operation area: that is particularly true for the abdomen, the whole surface of which should be prepared for every operation. Otherwise, if it should become necessary to prolong the incision or to make another at a distance, you may be compelled to invade the unsterilized area.

After soaping and brushing, the skin will be washed and rubbed, using sterile compresses, with spirit and ether and then with sterile saline solution, continuing the process as in the cleansing of the hands, until the latter liquid spreads uniformly over the surface of the skin.

All is now ready. Surround the operation area with four large boiled compresses or boiled towels, fixed at the corners by clips or safety pins, and spread others, so arranged as to cover any surfaces with which the hands or instruments may come in contact after the operation has begun. Any time you may think to gain by unduly curtailing these preliminaries is time irretrievably lost. It is the actual operation which requires to be carried out quickly.

Hæmostasis—Suture—Dressing.—To work quickly is the best means of sparing blood. Once the main object of the operation is achieved, give your attention to hæmostasis, and do not be afraid to devote all the time necessary to the work.

[1] If any septic contact has taken place (with pus, intestinal contents, etc.), a fresh washing with spirit is necessary.

Never close a wound which is not quite dry; *a fortiori*, never close an abdomen where some point still bleeds. We shall see later how dangerous these apparently insignificant oozings may be in the peritoneal cavity. Even in the regions which best lend themselves to the employment of compression, do not depend too much on it, and reserve "packing" as an exceptional method.

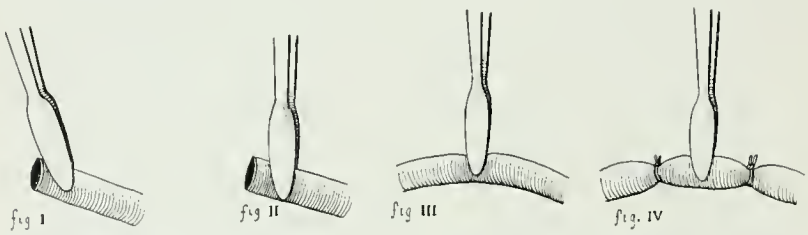

Fig. 7.—Methods of applying artery forceps: (i) Forceps badly applied, incompletely occluding the vessel, which continues to bleed; (ii) Compression across the cut end; (iii) Lateral compression; (iv) Ligature above and below, after lateral compression.

During the course of the operation, you have applied pressure-forceps to the bleeding vessels, or your assistant has covered them with swabs: raise these swabs one by one, and apply forceps to any point which still bleeds (*Fig.* 7), inspect the whole wound, then proceed to the ligatures.

It is not always necessary to ligature every little vessel which has been picked up: when the forceps are taken off, it will be found that many have ceased to bleed. Do not rely too much on that, however, especially in the regions where the skin is lax and the vessels retract readily, the perineo-scrotal region for instance; the cessation of bleeding is often apparent only, and, after some hours, blood reappears, forming hæmatomata and separating the layers of tissue. Therefore, **tie all the principal vessels and twist the others.**

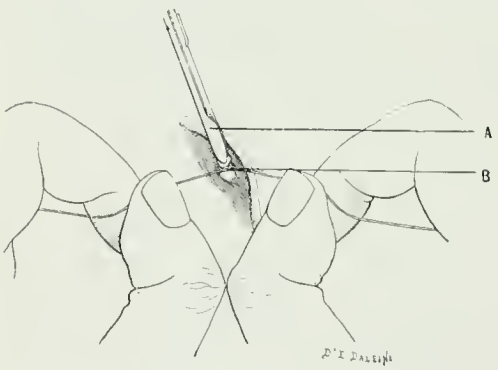

Fig. 8.—Ligature of a compressed vessel in a wound: (A) Pressure-forceps grasping and raising the end of the vessel; (B) Tightening the ligature, beyond the tip of the forceps.

You tie beyond the forceps (*Fig.* 8), the beak of which is tipped to allow the loop of the ligature to be slipped over the vessel and as high as possible; with some practice, you will be able to carry out the whole manœuvre without assistance (*Fig.* 9). This is simple when the vessel is caught by the end and isolated: it is much more difficult when you are dealing with intramuscular or deep-seated branches, caught by the side perhaps, or which lie buried in the tissues: the ligature refuses to free

itself from the jaws of the forceps, which are caught when you tighten the knot. Do not attempt to tie direct under these conditions : free the little vessel with the end of a director : it is a matter of a few moments, and gains time. Avoid the application of many indirect ligatures, which strangle large masses of tissue.

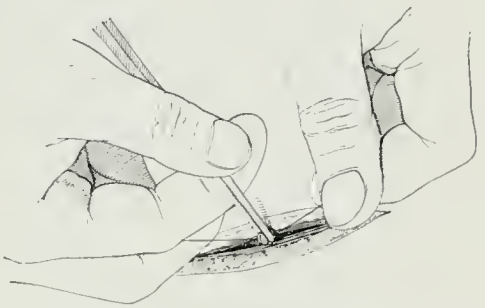

Fig. 9.—Ligature of a vessel without an assistant, the operator himself raising the tip of the forceps.

To properly apply torsion (*Fig.* 10) it is necessary that the cut vessel should be caught by the end and isolated from the surrounding tissues ; twist, *without pulling*, until the forceps come away in your hand.

If abundant oozing still persists, fill the wound with compresses and put pressure on them for a minute or so ; this will often suffice, and after you have gently withdrawn the compresses, you will find the bleeding has stopped and you can proceed to close the wound. Sometimes, when the bleeding comes from a deep-seated source, complete

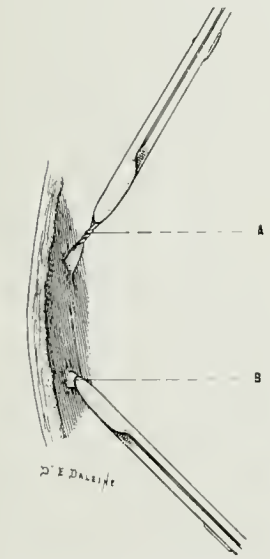

Fig. 10.—Torsion of a vessel in a wound. (A) A twisted vessel ; (B) Another vessel caught by the end with pressure-forceps, preparatory to twisting.

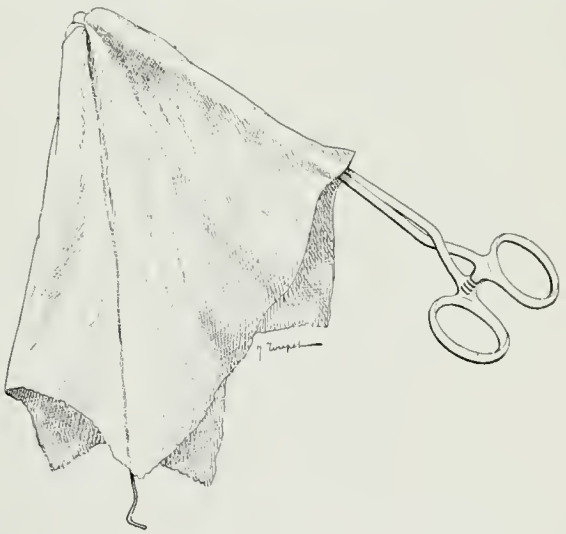

Fig. 11.—Mickulicz' method of packing. The sac with the attached thread, held with forceps ready for introduction into the wound.

hæmostasis is impossible : it is then necessary to pack the wound.

Packing ought to be done with sterilized gauze, in strips or disposed in a bag after the method of Mickulicz (*Fig.* 11). To carry out the latter,

cut a square piece of gauze, of appropriate size, to the centre of which a long silk thread is fixed; then fold it around a long pair of forceps, in umbrella fashion, and held thus, carry it to the bottom of the cavity to be packed; it only then remains to spread out the borders of this envelope and to pack into it as many strips of gauze as may be necessary.

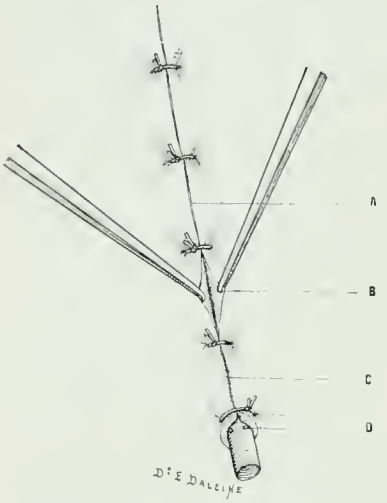

Fig. 12.—Interrupted suture of the skin. Adjusting the lips of the wound. Drainage tube at the inferior angle, fixed by a suture. (A) Skin edges, sutured and properly adjusted; (B) Two dissecting forceps, raising and adjusting the edges; (C) Skin edges turned in: (D) Drainage tube fixed by a suture.

Fig. 13.—The surgeon's knot; 1st stage. (It is fixed by a simple twist).

Do not forget that packing is never anything but a method of necessity; that it ought to be of brief duration; that it is *not a method of drainage*. It is worth while emphasizing the last point: with a crumpled-up strip of gauze or a "Mickulicz" tamponade, you will undoubtedly obtain some capillary drainage, but it is always unsatisfactory; *in order to drain, a drainage tube is necessary*.

If the wound has been soiled, or if it is lacerated and oozing, leave a drainage tube at the lower angle, projecting $\frac{1}{4}$ in. from the wound at the most, and fixed by a safety pin or point of suture (*Fig.* 12).

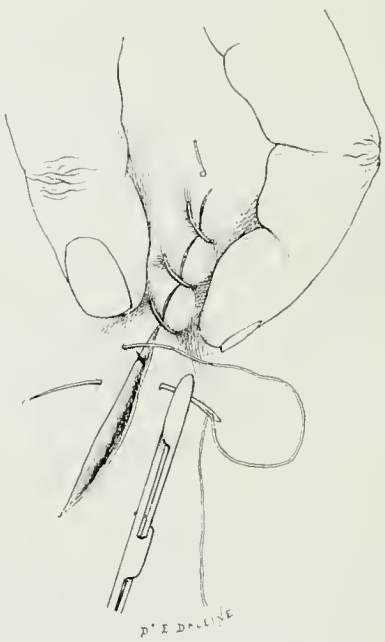

Fig. 14.—Continuous suture of the skin.

We shall return to the indications for, and methods of using, drainage, when considering the question of infected wounds. When.

however, the operation wound is clean and dry, then close it completely. Avoid any form of irrigation: content yourself with wiping carefully with dry swabs.

Sutures.—We shall study elsewhere the various types of suture of the deep tissues, in layers (*See* WOUNDS OF THE SOFT TISSUES). Excluding

Fig. 15.—First method of interrupting a continuous suture.

Fig. 16.—Second method of interrupting a continuous suture.

certain special indications, such as herniæ, it is often simplest first of all to pass a series of *deep sutures*, embracing in their loops all the thickness of the two margins of the wound, and then to adjust the skin edges by some

Fig. 17.—Third method of interrupting a continuous suture.

superficial sutures. The threads should be placed at right angles to the line of incision, properly spaced, and not tied too tightly; do not forget the surgeon's knot (*Fig.* 13), if you wish to work well and quickly.

It will often be expeditious, in uniting the skin wound, to substitute for the interrupted suture which we have just described, the continuous suture, carried out, in need, with an ordinary sewing needle (*Fig.* 14). If the incision is a long one, it will be well, every three or four stitches, to

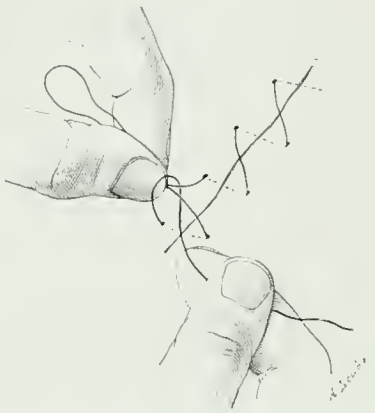

Fig. 18.—Termination of a continuous suture: first turn of the knot.

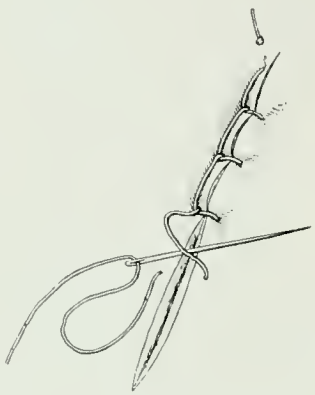

Fig. 19.—Reverdin's continuous suture.

arrest the suture, employing one or other of the methods represented (*Figs.* 15, 16, 17); for the final knot at the end of the suture, proceed as shown in *Fig.* 18.

In children, a continuous suture of fine catgut is an excellent method of uniting skin incisions: the suture is not touched again; it is simply left to be absorbed.

Lastly, the suture represented in *Fig.* 19, and recommended by Aug. Reverdin,[1] can also, with some practice, be executed with rapidity, and allows of regular approximation of the edges, especially when there is some tension on the wound.

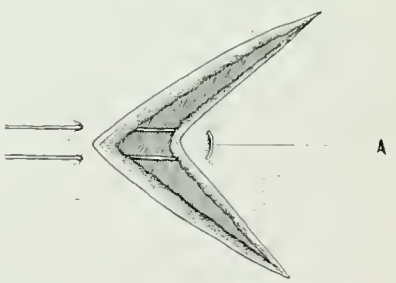

Fig. 20.—Loop suture for approximation of an angular wound.

In other cases, the skin wound may be irregular, and perhaps in places angular: the loop suture (*Fig.* 20) is the best for getting accurate adjustment in such conditions. Good cicatrices depend on *accurate adjustment* of the wound margins, and asepsis. Therefore, do not neglect to go from end to end of the line of union with two pairs of dissecting-forceps when the suturing is finished, raising any turned-in parts and adjusting the edges accurately (*Fig.* 12). (*For other details, see* WOUNDS OF THE SOFT TISSUES).

[1] *Soc. de chir.*, 2 mars, 1898.

The Dressing.—This ought to be as simple as possible. A good dressing should be *aseptic*, *absorbent*, and *protective* : nothing more, but nothing less.

Cover the sutured wound with one or more of the sterilized compresses, as dry as possible : outside that, a layer of absorbent cotton wool and a bandage ; *never introduce any impermeable tissue* into the dressing. (*See* WOUNDS OF THE SOFT TISSUES).

If it is useless to employ an excessive quantity of cotton wool—an extravagance which, however, it is not likely that the resources of improvised surgery will often permit—it is at the same time necessary that the layer should be sufficiently thick to fulfil its functions of *absorption* and *protection*. Lastly, every dressing ought to be completely covered in by bandages firmly fixed, and inaccessible from the exterior.

How often do wounds become infected because of badly applied dressings, which on the evening or day after operation gape on all sides, and speedily hang like rags around the trunk or limbs ! It will not be out of place to mention some points of general importance.

For the chest or abdomen, broad flannel binders, well applied (*see* WOUNDS OF THE ABDOMEN) and kept in position by thigh- or shoulder-straps, are the most useful.

On the neck (*Fig.* 25) a dressing will only hold in place and remain closed if care is taken to include the head and shoulders in the bandage ; otherwise it slips down and gapes at its upper border.

On the limbs (*Fig.* 24) the enveloping bandage ought always to extend widely beyond the dressing, above and below, and should also always pass *above the joint on the proximal side*, above the knee for dressings on the leg, above the ankle for those on the foot.

In the groin (*Fig.* 21) a good spica ought to be *double*, should come well down on the thighs, and extend well up over the abdomen ; a sheet of thin waterproof material should be placed around the scrotum to protect the dressing from urine. For the application of these dressings around the thighs and pelvis, Dittel's bandaging rods, the use of which is sufficiently indicated in *Figs.* 22 and 23, are very useful, as they permit a single person to support easily the lower limbs and pelvis beyond the end of the table.

These are simple precautions, but of very real importance, and though the dressing no longer represents the greater part of surgery, it always deserves the careful attention of the surgeon.

III.—ANÆSTHESIA, SALINE INFUSION, BLEEDING.

We must now study the subjects of anæsthesia and saline infusion, the latter being an indispensable factor in urgent surgery, and we shall also add some details regarding " bleeding."

Anæsthesia in Urgent Surgery.—Anæsthesia is necessary for the great majority of urgent operations. Apart altogether from the question of humanity—a point deserving the utmost consideration—it is often an essential condition for the rapid and satisfactory performance of an operation.

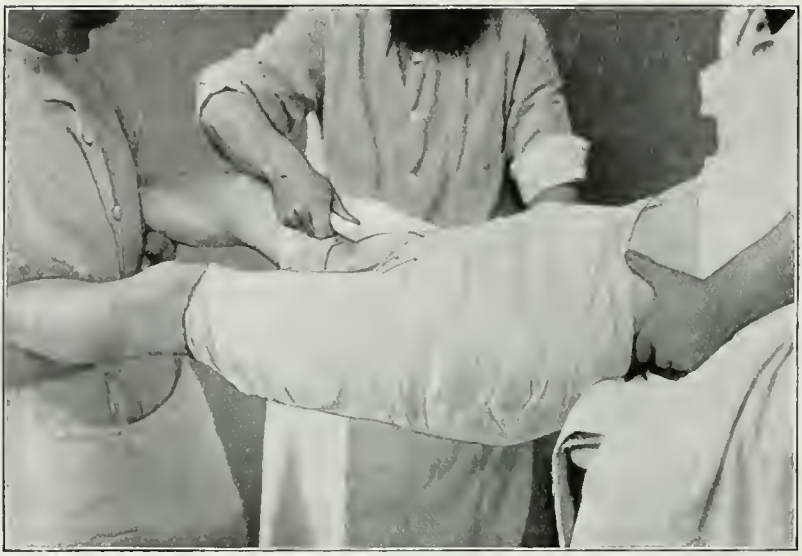

Fig. 21.—Double spica of the groin. The pelvis extends beyond the end of the table, supported by an assistant, while another assistant supports and abducts the lower limbs.

Fig. 22.—Application of a double spica of the groin, the patient being supported with the aid of bandaging rods.

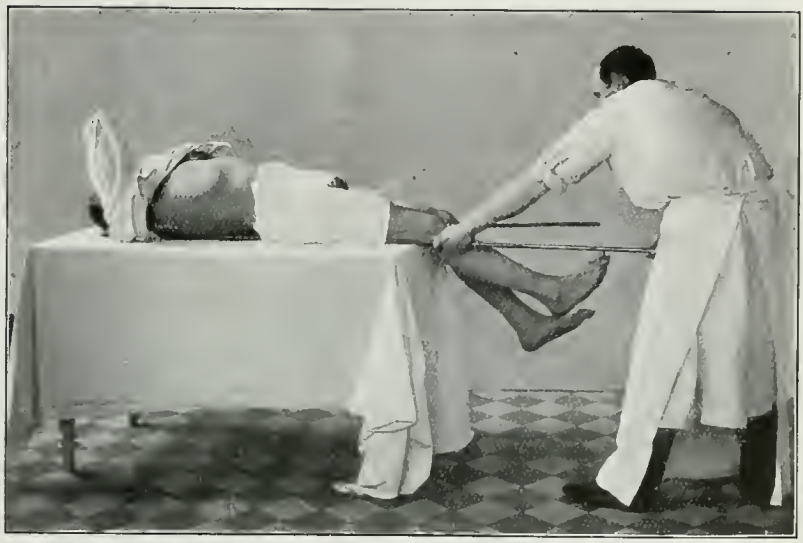

Fig. 23.—The rods are withdrawn when the dressing is completed.

Fig. 24.—A dressing of the leg (typical of dressings on the extremities). The bandage extends above the knee, and the dressing is carefully closed in above and below.

On the other hand, in these conditions, it often presents peculiar difficulties. In cases of intestinal obstruction, or strangulated herniæ in an advanced stage, after serious abdominal injuries, or serious hæmorrhages, chloroform administered without proper precautions and in large dosage, often becomes the immediate cause of death. The administration of general anæsthetics should always be with prudence and caution, and be closely watched. Finally, local anæsthesia with stovaine or cocaine is a valuable resource for the isolated practitioner.

A good practice, especially with patients suffering from septic absorption or excessive loss of blood, consists in giving a preliminary subcutaneous

Fig. 23.— Dressing of the neck, taking in the head, and closed below by a double crossing on the chest. A corner of the piece of waterproof tissue, which protects the front of the dressing, is visible. Method of supporting the semi-conscious patient.

injection of saline solution, and continuing it if necessary *throughout the whole course of the operation.*

It will sometimes be necessary to disregard cardio-pulmonary lesions which would be absolute contraindications to the administration of an anæsthetic under less urgent conditions. I have never seen a worse case of aortic insufficiency than in a patient at La Pitié, whose thigh I amputated for diffuse aneurysm. The chloroform was given drop by drop with the greatest care, and there was not the slightest trouble. It is also at times necessary to administer anæsthetics to persons who have taken food a

short time previously: should this be so, if the stomach is distended, a preliminary gastric lavage is advisable.[1]

Chloroform, ether, and cocaine or stovaine are the anæsthetics to be provided.[2]

Chloroform.[3]—The advantage of chloroform is that no special apparatus is required:[4] a handkerchief or a simple compress will meet all requirements;[5] but a small mask is always preferable, the chloroform being poured drop by drop on the outer surface, without any necessity for reversing the apparatus.

If you have only a handkerchief, fold it in a square,[6] pour some drops on one of its surfaces, and apply it to the nose and mouth of the patient:[7] the upper border is held with the thumb and index finger of the left hand against the bones of the nose, while the other fingers remain free to raise the eyelid or palpate the temporal artery: the lower border is raised into a ridge with the right hand, at the level of the chin, to allow a free entry of air (*Fig.* 26). The dangerous period of the administration is at the outset;[8] begin, therefore, with little chloroform and plenty of air, and above all, approach the handkerchief to the face gradually; let the patient have time to get accustomed to the smell, advise him to breathe through the mouth, speak to him, attract his attention, if possible; in some clinics it is the custom to make the patient count while he is being anæsthetized.

There is another method, which greatly hastens matters: the compress, impregnated with chloroform, is closely applied to the face at once, all air as far as possible being excluded. This succeeds with children in the hands of an experienced administrator; in the adult, as a general rule, this method of "suffocation" is extremely dangerous, and I should say that the first stage of chloroformization should always be a stage of persuasion; it is necessary to feel your way with the patient, to coax him, to study him.[9] The few minutes thus spent will be quickly regained.

Pour on the chloroform in small quantities (5 or 6 drops), and as respiration becomes deeper and steadier, fold in the compress, to reduce

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[1] See Intestinal Obstruction for the indications for preliminary gastric lavage.

[2] Here I restrict myself to the consideration of these anæsthetics only; properly used, they will suffice for all the needs of urgent practice. Of course, for small operations, opening abscesses, etc., the ether or ethyl chloride spray is useful.

[3] The chloroform must be of good make and properly preserved (*see p.* 3); any partly empty or uncorked bottles ought to be rejected. The only points whereby the practitioner can judge the purity of his chloroform are the smell, limpidity, and absence of residue when evaporated.

[4] Let us mention here, that it is dangerous to give chloroform in a badly ventilated room which is lighted or heated by gas; it forms the very toxic carbonyl chloride, which may even have fatal effects on the patient or others present.

[5] I need only mention the chloroform apparatus of Roth-Drager, Vernon-Harcourt, Ricard, etc., which, spite of their advantages, cannot be conveniently employed in extempore surgery.

[6] Remember to look for false teeth, and remove them if present.

[7] Smear a little vaseline over the nose, lips, and eyelids of the patient, to prevent the irritation of the skin which follows accidental contact with chloroform. Take care to pour the liquid gently on to the mask. I have twice seen most painful and obstinate conjunctivitis due to the careless dropping of some chloroform into the eye.

[8] Fear undoubtedly plays an important part in the production of fatal inhibitory reflexes.

[9] "Each narcosis is an experiment": Mickulicz's remark is superlatively true.

the entry of air to the necessary minimum. Repeat the dose of the anæsthetic every half minute : drop it on the outer surface at the level of the nose, then reverse the compress sharply. If there is any struggling, increase the dose a little ; *if the patient shows signs of vomiting, increase it still further, and push the chloroform :* that is the best and surest method of checking it. By employing this plan of small, continuous doses, time is saved and the patient gets less chloroform.[1] Once anæsthesia is obtained —and it is very bad practice to begin the preparation of the operation field before the patient is properly under the influence of the drug—it is

Fig. 26.—Administration of chloroform. Folded compress : observe the disposition of the anæsthetist's fingers. The tongue forceps, duly sterilized, are placed within reach of the anæsthetist, in a small sterilized tray.

the duty of the anæsthetist to restrict the dosage as far as possible. If he knows his work, he will keep a constant watch on the respirations,[2] the face, the pupils, and the oculo-palpebral reflex ; he will observe the slightest tendency to returning consciousness, and will meet it by pouring a few drops on the compress, his constant study being to reduce the total dose of the anæsthetic to a minimum. When the patient is in bad condition,

[1] See, for a detailed consideration of this method, the work of Marcel Beaudoin, "De la chloroformisation à doses faibles et continues," *Gazette des hôp.*, 7 et 14 juin, 1890. On an average, about 2 dr. of chloroform are required to obtain anæsthesia by this method in a quarter of an hour : and to maintain it, from 4 to 6 dr. per hour. A certain degree of practice is necessary to enable one to work with such reduced doses.

[2] It is much more important to watch the respirations than the pulse : the anæsthetist should all the time see and hear his patient respire.

the anæsthesia will be interrupted at the earliest possible moment, without waiting for the completion of the skin suture. We shall see presently what is to be done when mishaps occur during the administration.

Ether.—This anæsthetic has two important disadvantages in urgent surgery: (1) it is dangerous at night near naked lights or in a small room with a fire: (2) it requires a special mask, or at least some special apparatus.

With these reservations, it must be recognized, without in any degree wishing to exaggerate the frequency with which accidents occur during the administration of chloroform, that the use of ether is associated with less immediate danger; above all, it is free from the risk of acute heart failure in the initial stages which has caused so many sudden deaths: further—and the fact is generally admitted—its use is followed by much less shock after long, and particularly after serious abdominal, operations.

It has an important contraindication however, namely, any affection of the respiratory tract. If the patient has a slight bronchitis, a cough, or emphysema, or extensive tuberculous lesions,[1] the inhalation of ether will often give rise to severe broncho-pulmonary trouble, during or after anæsthesia; under these conditions, therefore, it should not be employed.

Fig. 27. Julliard's ether mask.

The mask shown in *Fig. 27* is one of the simplest forms made: indeed, it can be improvised with the aid of some brass wire, a piece of thin waterproof material, and a compress. In case of need, a thin sheet of cardboard, an almanac rolled in a cone and tied, in the bottom of which a crumpled compress is fixed, will make an excellent temporary mask.

Naturally, as ether is so much more volatile than chloroform, a comparatively larger quantity of the former must be used. Pour first of all about half an ounce on the compress, and apply the mask or cone gently over the nose and mouth of the patient; as soon as he begins to take it properly, pour on a fresh dose, and hasten the first stage (*Fig. 28*): if you are too sparing with the anæsthetic and too timid at the outset, the induction period will be excessively prolonged, and in the end the patient will get a much larger quantity of the anæsthetic than if it had been pushed at first.

[1] We might add also, that during the prevalence of influenza we have observed many cases of influenza amongst our patients after ether: it was, however, not severe, and had no bad influence on the operative results (see Boutin, "La grippe chez les opérés," *Thèse de Paris*, 1895).

Here, again, as soon as anæsthesia is induced, you will diminish the dose and continue with as little as possible.[1] In general anæsthesia, either with chloroform or ether, the points requiring constant and careful attention are the *respiration* and the *appearance of the face*, the principal accident to be feared being **asphyxia.**[2]

Fig. 28.—Administration of ether.—Immobilization of the patient on the operating-table.[3] A sheet, folded lengthwise, crosses the front of the thighs above the knees, passes under the table, and is knotted at the side; a bandage is attached to one wrist and then carried beneath the table to be fastened to the other.

The anæsthetist must keep a constant eye on the movements of the chest and abdomen. If the respiration is getting shallow, lift the compress or mask from the face; if the face is blue, stop the anæsthetic

[1] Three to five ounces of ether suffice for an anæsthesia of an hour's duration; it is one of its advantages that the working dose is much larger than that of chloroform.

[2] Anæsthesia may also be followed by other mishaps, over which we have no control: I refer particularly to the various paralyses of central origin, the hemiplegias, the monoplegias, the disseminated paralyses, quite different from the peripheral palsies due to compression which are mentioned below. For example, I operated at La Pitié on a man sixty years of age for cancer of the tongue. The operation was simple. As soon as consciousness returned, a facial paralysis was observed; by the evening there was complete hemiplegia; the patient succumbed some days later, and the autopsy disclosed a large hæmorrhage into the right hemisphere. Other accidents of a similar character and of varying gravity have been observed, often after comparatively small operations of short duration, such as the extraction of a wisdom tooth, under chloroform. Apart from some inexplicable cases, these paralyses are due to cerebral hæmorrhage or hysteria. The influence of the anæsthetic in the production of such conditions is uncertain; perhaps the duration of the operation, the quantity of anæsthetic absorbed, the length of the stage of excitement, and the patient's struggles in that stage, are all factors which ought to be taken into consideration. When it is necessary to administer an anæsthetic to a patient with a predisposition to cerebral hæmorrhage, an old man, for instance, with sclerosed arteries, you must exercise the utmost care, and it is also advisable to mention the unavoidable dangers of anæsthesia.

and give the patient plenty of air: raise the base of the tongue with the fingers placed within the angles of the lower jaw (*Fig.* 29), or, seizing the tongue with the forceps (*Figs.* 30 & 31), draw it gently forwards: a loud respiration often indicates that the difficulty is overcome, and the bluish tint disappears. Replace the mask at once, but take care that air is allowed to enter freely.

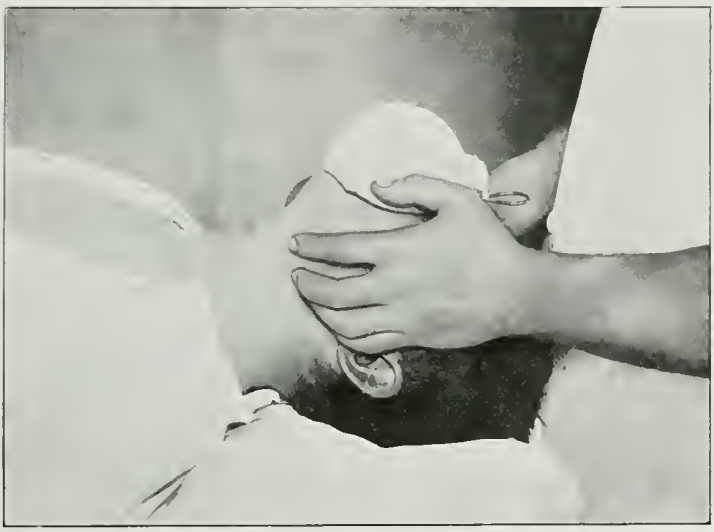

Fig. 29.—Raising the angles of the jaw in anæsthesia.

The situation is much more disquieting when the respiration is almost stopped, the pulse small, the face leaden, the pupils dilated: lay aside the apparatus at once, let the head fall well back, take hold of the tongue with the forceps and make rhythmical tractions, methodically and without

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[3] A complete and well-watched anæsthesia is the best method of immobilization: nevertheless it is well to make sure of the four limbs, and the ties represented above are generally sufficient when the patient is to be operated upon in the dorsal position. Whatever may be the method of fixation, any compression must be carefully avoided, and it is also to be remembered that in a patient under the influence of a general anæsthetic, the suppression of muscular resistance exposes the great nerve trunks to the risk of injury, and also renders exaggerated movements only too easy.

This is the usual origin of the post-operative peripheral palsies: paralysis of the muscles of the shoulder and arm (deltoid, brachialis anticus, biceps, supinator longus), musculospiral paralysis, paralysis of the sciatic or external popliteal nerves, etc. They are due to forced abduction of the arm, which stretches the brachial plexus and compresses it between the clavicle and the first rib; to faulty fixation of the arm, encircled above the elbow by a bandage, and pressing heavily with its inner surface against the edge of the table, or perhaps rolled under the trunk in the lateral position: to the prolonged pressure of the buttocks against the badly cushioned edge of the table in the gynæcological position; to the pressure of the popliteal tissues against the angle of the inclined planes in the Trendelenburg position.

I have seen two typical cases of musculospiral paralysis, quite evidently caused in the manner above indicated. These palsies are, as a rule, curable, but their gravity varies naturally with the duration of the anæsthesia, that is to say, of the compression.

It is well to be aware of these facts in urgent surgery, where the lack of assistance often necessitates immobilization of the patient (see Schwartz, *Les paralysies post-anesthésiques. Comptes rendus du Congrès de chirurgie*, 1897, p. 688, and Morat, *Thèse de doct.*, 1898).

haste. Draw the tongue out, let it fall back; repeat the proceeding regularly, quietly, and without violence. I have several times seen the tongue torn and the frænum cut, under the traction of agitated hands, the owner of which had forgotten that rhythm is, as Laborde has taught us, the basis of this valuable method.

If the patient does not at once begin to breathe naturally, it is necessary to employ *artificial respiration* (*Fig.* 32, 33) without delay, in addition to the rhythmical traction on the tongue, and also flagellation with a wet towel.

Artificial respiration is performed by movements of the arms, by compression of the base of the chest, or better, by a combination of both methods.

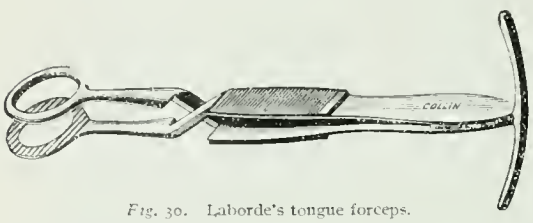

Fig. 30. Laborde's tongue forceps.

Place yourself behind the patient's pendant head, take hold of the arms above the elbows, and press them downwards and forwards against the base of the chest (*stage of expiration*, *Fig.* 32); then withdraw them from the trunk and carry them upwards and backwards into the position of maximum abduction, so pulling on and raising the ribs through the intermediary of the pectoral muscles (*stage of inspiration*, *Fig.* 33).

To carry out compression most effectually, it is best to get on the table, kneel over the patient, and with the outspread hands embracing the base of the thorax as widely as possible, compress it firmly but without violence; then, withdrawing the hands, allow the elasticity of the ribs to come into action.

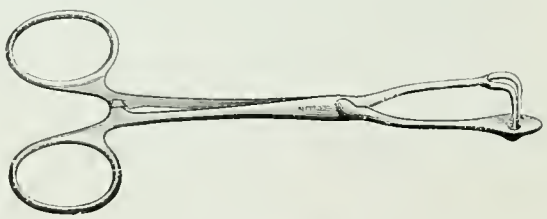

Fig. 31.—Berger's tongue forceps.

The maximum useful effect is obtained with two persons working together, combining both procedures, as shown in *Figs.* 32 and 33.

If the symptoms do not speedily yield to these measures, give a large intravenous infusion of saline (2 to 3 pints); in cases of syncope in the initial stage, this infusion ought to be practised at once, without waiting to see what benefit may attend the employment of the ordinary methods.

As to other measures, electrical stimulation of the phrenic nerves, tickling the epiglottis, tracheotomy followed by insufflation of oxygen into the trachea, massage of the heart—these are of very little value when rhythmical tongue traction and artificial respiration, properly done, have failed.

Chloroform or ether should always be the general anæsthetic of choice in urgent surgery, and properly used will meet all indications; very good

Fig. 32.—Artificial respiration : expiration.

Fig. 33.—Artificial respiration : inspiration.

results are obtained, however, with certain anæsthetic mixtures, especially Billroth's, composed of chloroform, 100 parts; alcohol, 95 per cent, 30 parts;[1] ether, 30 parts.

For operations of short duration, chloride of ethyl has some very decided advantages: induction is rapid, and the awakening also; but the abrupt manner in which it must be administered renders its use inadvisable for those who have not had previous experience with it.[2]

Cocaine and Stovaine in Local Injections.—The only solutions used are those of ½ per cent and 1 per cent;[3] cocaine is steadily giving way to stovaine, which is almost as powerful an analgesic and notably less toxic, and can therefore be employed in much larger doses. The maximum total dose of hydrochloride of cocaine is 15 cgrams (2¼ gr.), that is 30 cc. (8 dr.) of the ½ per cent solution or 15 cc. (4 dr.) of the 1 per cent; of stovaine, 30 to 40 cgrams (4–6 gr.) may be injected[4], thus permitting the use of a large quantity of the solutions, say 40 cc. (12 dr.) of the ½ per cent, and enabling the operator to anæsthetize a very large field. The solutions must be aseptic,[5] and the syringe sterilized.[6] Do not charge the syringe directly from the bottle, but sterilize some small suitable vessel and pour the solution into it.[7]

There are many patterns of syringes; the essential quality is that all the parts may be boiled without damage.

The injection ought to be made *into, not under, the skin*, along the line of the future incision; when the liquid has penetrated properly into the derma, a whitish, prominent wheal, finely mammillated like the skin of an orange, marks its track, and indicates the line which the knife must follow (*Fig.* 34).

[1] To obtain a clear mixture, it is necessary that the alcohol should be of 95 per cent strength.

[2] You may also employ "ether intoxication," according to the method of Südeck and Küttner, for some very brief manipulations, which are not easily carried out—or are impossible with local analgesia—reduction of some dislocations or fractures of the radius or malleoli, incising abscesses or whitlow—by taking advantage of the analgesia which generally follows the first inhalations of ether, the condition akin to acute alcoholism, which precedes the stage of excitement. Of course, it is necessary to carry out the task very quickly, and to have everything ready in advance; tell the patient to breathe deeply, let him continue to do so for a minute, then pour 5 or 6 dr. of ether into the mask, and bring it quietly in front of his nose and mouth; finally apply the mask closely, whilst the patient, "carried away," and without doubt in some degree hypnotized, continues to take very deep breaths. After ten to fifteen inspirations the intoxication is obtained; proceed, then, as quickly as possible. Unfortunately this intoxication is not always calm and inert, but is often associated with violent struggling which necessitates the assistance of many hands.

[3] The solution should contain ·8 per cent of sodium chloride, so that it may be isotonic with the fluids of the body.

[4] In British practice the maximum dose of cocaine is 3 cgrams = ½ gr. and of stovaine about 9 cgrams = 1½ gr. (Translator).

[5] The solutions should have been recently prepared, not more than two or three days previously; if older, they lose a great deal of their analgesic powers. They cannot be boiled without risk of decomposition; the best method of sterilization is to put them, enclosed in sealed glass capsules, in a water bath, the temperature of which is several times raised to 60° C., or in a steam sterilizer at 120° C., (see p. 34). It is well also to warm the solutions to 48° C. or 50° C. before using them; not only are they thus rendered less harmful to the living tissues, but their analgesic properties are notably increased.

[6] An important detail emphasized by Tuffier: do not boil the needle or the syringe in water containing any bicarbonate of soda, which decomposes both cocaine and stovaine.

[7] If you have stovaine or cocaine in sterilized glass capsules, you will then, of course, charge the syringe directly, introducing the needle into the neck of the capsule.

We cannot do better than quote M. Reclus' description of the technique : " I fix with my eye the exact position and extent of my future incision ; at one of its extremities, I introduce the point of the needle ; if at the first thrust I have penetrated into the subcutaneous tissue, I withdraw it a little so that the point may lie in skin ; then I push the piston gently ; a little white swelling appears in the skin, and from that moment no more pain should be caused by the injection ; if the patient suffers, it is the fault of the operator.

" He must introduce the needle slowly into the thickness of the skin, and pushing the piston as the needle advances, the cocaine anæsthetizes the tissues in such a manner that they are already insensible when the instrument traverses them. It is necessary to keep in the tough skin tissue, a position which is easily recognized by the white swelling which follows the track of the fluid, and the resistance to the passage of the needle.

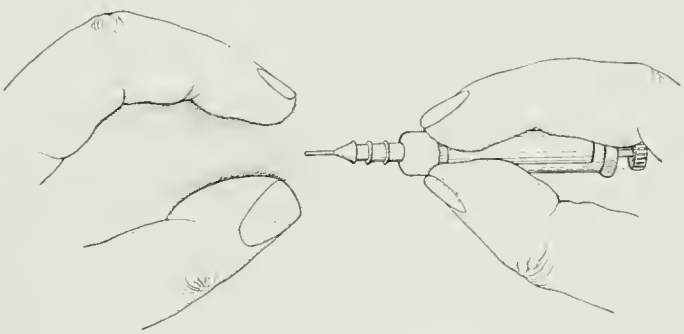

Fig 34.—Intradermic injection of cocaine.

Sometimes the needle is too short to cover the whole length of the future incision in one stage : it is then withdrawn, and after being recharged if necessary, is again buried in the skin, a little behind the point at which the injection had been stopped, because this region is already anæsthetized, and a prick there is not painful."[1]

The quantity to be injected will vary, naturally, with the length of the incision : it will be well to inject one or two syringefuls at once into the subcutaneous tissue.

Before making the incision, wait five or six minutes, to allow the analgesia to become complete ; the knife must follow exactly the track of the injection.

Once in the depths, the anæsthetizing process must be continued, by repeating the injections into the thickness of the successive planes of tissue.[2]

[1] Thanks to this method, the first puncture alone is painful, the analgesic track is uninterrupted, and if the needle meets a vein of any size, it traverses it quickly, discharging into it an extremely small quantity of the solution.

[2] The patient ought to be in the horizontal position, at least when cocaine is being used, and it is a useful precaution to give him, during and after the cocainization, a hot and comforting drink (coffee, brandy). See for the details of the method, M. Reclus' book : *L'anesthésie localisée par la cocaine.* Paris, Masson, 1903.

Thus practised, local anæsthesia, though ill adapted for atypical operations, involving large areas and of complex technique, and to abdominal operations in particular, will yet render most valuable service in urgent surgery to him who knows how to use it ; we shall frequently have occasion to refer to it (operation for empyema, strangulated hernia, artificial anus, cystotomy, etc.).

Infiltration Anæsthesia (Schleich[1]).—This method of producing local anæsthesia is common in Germany, but very little employed in France or Great Britain. The solutions used are very weak, but they are injected in large quantities ; by this means an analgesia is obtained which is less complete, and, still more important, less durable, but spread over a much wider area, thus providing a larger field for the subsequent surgical manipulations, and which is also, thanks to the reduced dose of the alkaloid, quite free from danger.

The solution commonly employed has a strength of 1–1000, made up as follows :—

Cocaine Hydrochloride	0·10 gram
Morphine Hydrochloride	0·02 gram
Sodium Chloride	0·10 gram
Water, distilled and sterilized	100 grams

Two ounces of this solution would contain only 1 gr. of cocaine.

The following is the technique : The needle is thrust, slowly and obliquely, into the deep layer of the derma—not under the skin—and the contents of the syringe are injected ; a little whitish swelling appears ; the needle is now withdrawn and reintroduced near to, but within the edge of, the first infiltration swelling. A second swelling is produced, then a third, and so on over all the area to be anæsthetized. Several syringefuls should then be injected into the subcutaneous tissue and diffused by a little massage. During the course of the operation, the successive layers of tissue are *infiltrated* as they are met with—muscles, aponeuroses, periosteum, nerve trunks, etc.[2]

Regional Anæsthesia.—Now let us describe the injection, in continuity, of the nerve trunks, a method which, at least on the extremities, the fingers and toes, or the penis, allows us to obtain complete anæsthesia with a very small quantity of the drug employed, and which is of great service in many small operations.

[1] Schleich. *Schmerzlose Operationen*, 4 Aufl., 1899.

[2] These deep tissues possess very different degrees of sensibility, which varies also according to the degree of inflammatory hyperæmia. In addition to the ordinary solution, given above, Schleich recommends the use of two others : the one, strong, with a strength of 2–1000, one ounce of which contains 1 gr. of cocaine, used for inflamed or highly sensitive tissues ; the other, weak, with a strength of 1–10.000, one ounce containing ½ gr. of cocaine, intended for tissues of very low sensibility. The formulæ for these two solutions are as follows :—

	Strong	Weak
Cocaine Hydrochloride	0·20 gram	0·01 gram
Morphine Hydrochloride	0·02 gram	0·005 gram
Sodium Chloride	0·20 gram	0·20 gram
Water, distilled and sterilized	100 grams	100 grams

Suppose a whitlow is to be opened (*Fig.* 35), the finger is encircled at its base with a piece of fine rubber drainage tubing, which is secured with a pair of pressure-forceps[1]: on its two surfaces, at the sites of the four collateral nerves, four injections are made under the skin from behind forwards; each injection consists of 5 or 6 drops of the 1 per cent solution of cocaine. With 2 cgrams ($\frac{1}{3}$ gr.) of cocaine, the whole finger will have become insensible at the end of five minutes (Oberst).

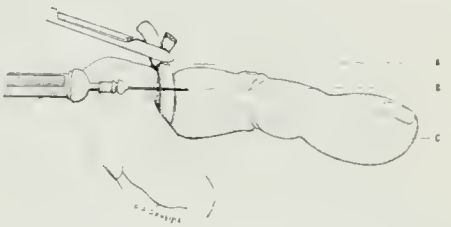

Fig. 35.—Regional anæsthetization of a finger (Oberst). (A) Rubber tube constricting the base of the finger. (B) Injection, along the line of a collateral nerve. (C) Whitlow, to be incised.

Reclus employs no preliminary constriction:[2] he surrounds the base of the finger with *a ring of anæsthesia* by means of a circle of injections (*Fig.* 36): at the root of the finger "the point of the needle is introduced with a sharp thrust, not into the skin, but beneath it, into the subcutaneous tissue; while the needle is caused to travel slowly forwards, the contents of the syringe are expelled:[3] an œdematous swelling is produced, over which the skin turns pale; into this blanched and analgesic skin another puncture is made, without causing pain, and another syringeful of the solution is slowly injected. Continuing thus, four punctures with 6 or 7 cgrams (about 1 gr.) of cocaine suffice to produce in the subcutaneous tissue around the root of the finger a ring of anæsthesia which is made evident by a marked swelling and by the lividity of the skin. After a few minutes the finger is found absolutely insensible from base to tip."[4]

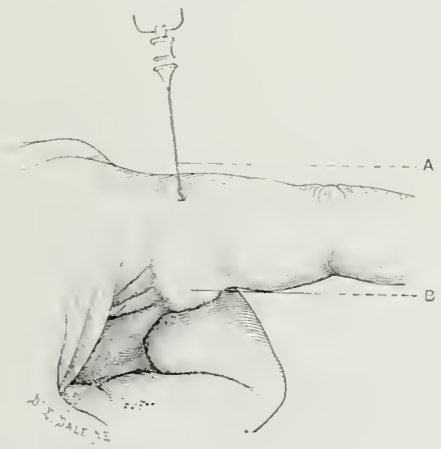

Fig. 36.—Regional anæsthetization, circumferential injections at the root of the finger: anæsthetic ring (Reclus). (A) Needle introduced under the skin at the base of the finger. (B) Anæsthetic ring.

[1] Naturally, as soon as the tube is removed, the cocaine is absorbed and the anæsthesia disappears.

[2] This constriction is moreover very painful.

[3] The $\frac{1}{2}$ per cent solution is the one used.

[4] We may here mention cocaine-adrenalin, obtained by adding 5 or 10 drops of a 1–1000 solution of adrenalin to 4 oz. of the 1 per cent solution of cocaine. The addition of adrenalin gives a more complete and lasting analgesia, and produces also a very useful vasoconstriction. It is particularly to be recommended when it is necessary to operate on inflamed tissues. (*See* PANARIS). Novocaine, less toxic than cocaine, and sterilizable by boiling, may also be employed in $\frac{1}{2}$ per cent and 1 per cent solutions, to which a few drops of the 1–1000 solution of adrenalin may be added with the same advantages as when combined with cocaine.

Spinal Anæsthesia.—The injection of stovaine into the subarachnoid space is still an exceptional method, only to be employed in certain conditions, where local anæsthesia would be insufficient and general anæsthesia is contraindicated by the state of the heart or the respiratory apparatus; it cannot be recommended, in ordinary practice, as a simple, safe, and certain method.[1] With these reservations, the following is the technique to be adopted. It is necessary to have :—

1. A 10 per cent **solution of stovaine,**[2] in glass capsules, carefully prepared, sterilized in an autoclave at 115° C., containing usually $\frac{3}{4}$ of a cc. of the solution and therefore 7·5 cgrams of the drug.

2. A **glass syringe** with a capacity of 1 cc., graduated in 20 divisions, and a **needle long enough to penetrate the spinal canal.**[3] The syringe and the needle are sterilized in an autoclave or by boiling.[4]

The average dose for spinal injection is 4 *cgrams of stovaine.*

First of all charge the syringe by breaking off the beak of the capsule and aspirating the contents with the needle; do not more than half fill it; then, holding it vertically, expel a little of the fluid and any air which may have been drawn in, retaining only 8 divisions, $\frac{4}{10}$ of a cc. of the solution, that is, 4 cgrams of stovaine. Now remove the needle from the syringe and make the puncture.

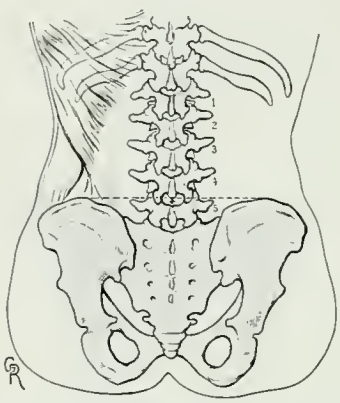

Fig. 37.—Transverse line joining the summits of the two iliac crests and passing between the 4th and 5th lumbar vertebræ (Tuffier).

The **puncture**[5] will be made between the arches of the 4th and 5th lumbar vertebræ, and the needle must pass through the skin, the subcutaneous fatty tissue, the erector spinæ muscle, the ligamentum subflavum, and the spinal theca. *A transverse line, joining the two iliac crests, crosses the interval between the 4th and 5th lumbar vertebræ at the level of the interlaminar space where the puncture is to be made* (*Fig.* 37).

Have the patient seated, with legs hanging, the arms in front, the head inclined forward, the back well rounded.

With washed hands, soap, brush and prepare the whole lumbar region

[1] The chief ill effects associated with spinal analgesia are the following: During the course of the analgesia, *a feeling of malaise*, at times going on to *syncope*; *nausea*; *vomiting*; subsequently, *headache*, which appears from the sixth to the eighth hour after operation and lasts usually until the next day, but sometimes much longer; *rise of temperature*; *retention of urine*. Lastly we must not forget the fatalities nor the cases of late paralysis which have recently been reported.

[2] With the addition of an equal quantity (10 per cent) of sodium chloride.

[3] The needle recommended by Tuffier is made of iridium-platinum, it is 8 cms. long, 1 mm. external diameter, and $\frac{1}{6}$ mm. internal diameter.

[4] *See* footnote 6, p. 30.

[5] It is useful to know the technique which follows, as there are many important indications for spinal puncture in addition to the production of anæsthesia.

as if for an operation. Then mark the position of the two iliac crests (*Fig.* 38); with the fingers follow the line which unites them; on this line or a little above it, the spine of the 4th lumbar vertebra will be found.

Take time enough to make sure of this spine; hold it firmly between the left thumb and index finger, and, taking the needle in the right hand, introduce it gently at a point half an inch from the middle line and just below the outer edge of the left index finger from behind forwards (*Fig.* 39). *The attitude of the patient is of the first importance;* take care that he is comfortably seated and well bent forwards. The prick usually provokes an involuntary straightening of the vertebral column: warn the patient therefore before puncturing, and above all, puncture gently: go through the skin only, at first—that is the painful stage—wait until the instinctive defensive movement has passed off, then continue the puncture.

Fig. 38.—The summits of the two iliac crests marked with the fingers; a transverse line joins them and passes between the 4th and 5th lumbar vertebræ.

Go in steadily until the cerebrospinal fluid, a clear, limpid, slightly yellowish liquid, *runs in large drops from the needle:* so long as we do not see the clear fluid flow in this manner, we may be sure that we have not yet reached or are no longer in the subarachnoid space.[1]

Do not allow the fluid to escape unnecessarily; fit the charged syringe to the needle at once, and allow it to fill with the cerebrospinal fluid, the pressure of which is sufficient to force back the piston. When it is quite full,[2] inject the whole contents, slowly and steadily. Then withdraw the needle and close the puncture with collodion.

It may be necessary to make the injection in the horizontal position. Have the patient lying on the left side, the spine strongly flexed, and the

[1] Sometimes, though the needle penetrates deeply without encountering any obstacle, nothing comes: if the needle is a little withdrawn, the fluid will often appear. At other times, it is blood that escapes from the needle: wait; often, after some drops of blood, the liquid becomes less red, then quite clear. Or perhaps, after the blood, the flow stops—a clot, probably; withdraw the needle, clear it, and puncture afresh. Lastly, a blank puncture is more common than is usually admitted: (*a*) The point comes in contact with some hard surface, a lamina probably: draw the needle backwards, and change the direction a little upwards or downwards; do not expect too much from the alteration however: it is often better to begin again. (*b*) The needle penetrates freely and deeply, but nothing comes: withdraw it a little, rotate it, incline it in one or other direction, in order to disengage the point: again, it may be necessary to make a fresh puncture. It is well to repeat that the attitude of the patient is of the greatest importance.

[2] With stovaine the liquid becomes opalescent.

thighs drawn up (*Fig.* 40); determine the position of the iliac crests and the 4th lumbar spine as before, and direct the puncture a little obliquely upwards and inwards.

After the injection is given, it is necessary to wait for ten minutes, sometimes a little longer, for the analgesia to develop; during this time the field of operation can be prepared.

When completely successful the operation is completed with striking serenity; the patient retains some tactile sensibility, but feels no pain; he lies in a state of indifference, responds to questions, and may be of some help in the dressing.

Fig. 39.—Spinal puncture, the patient in the sitting position.

The analgesia lasts, usually, from an hour to an hour and a half. Although it may be made to extend up to the thorax, to the clavicles, and even to the head, by using stronger doses (from 7 to 10 cgrams of stovaine, for example), such attempts are not to be recommended, and, in the conditions of urgent surgery, spinal anæsthesia will only be applicable—and then exceptionally—to operations on the lower extremities, the perineum, the genito-urinary organs, and the sub-umbilical region; it should never be employed in abdominal surgery proper.

The Use of Saline Solution in Urgent Surgery.—We shall often have cause to refer to the indications for the injection of normal saline solution. The great assistance we may expect from this valuable procedure

—its value has been abundantly proved—makes us hope that its use will become increasingly popular.

If not as widely used as it deserves to be, and if it does not, in all hands, give the results we have the right to expect, this is chiefly because of two erroneous ideas: first, a belief sometimes held, that the application is troublesome and the technique complicated; second, it is often employed in too timid and parsimonious a fashion, the quantities administered being much too small to be of real use.

The *subcutaneous method*, which is the *method of choice*—the intravenous route being reserved for special conditions—can be employed with the aid of apparatus which may be improvised anywhere.

Fig. 40.—Spinal puncture, the patient in the left lateral position.

The best **solution for injection** is one containing 9 parts per 1000 of sodium chloride.[1] A teaspoon filled with salt, finely powdered and pressed down, contains 7 grams (108 gr.); if the salt is simply poured into the spoon, one spoonful is equal to 4·5 grams (70 gr.) (Faney). Therefore, throw two teaspoonfuls of table salt into a litre of water, and boil it for half an hour at least,[2]—a teaspoonful lightly pressed down, to the pint of water is approximately correct. The water should be filtered through cotton wool

[1] The really "normal" solution of sodium chloride should be, not 0·7 per cent, but 0·9 per cent; the latter solution alone is isotonic with the blood serum (its freezing point is 0·56 below that of distilled water, and therefore practically the same as that of blood serum), and is consequently harmless to the blood corpuscles and cellular tissues. For intravenous injections, and also for peritoneal lavage, it is particularly important to use solutions of the proper physiological strength.

[2] That is to say, the solution ought always to be prepared in advance, before the operation, and it ought to figure in the list of "necessary liquids" which every practitioner should have in reserve. Even for a subcutaneous injection, the solution ought to be warm (38°–41° C.).

if not perfectly clear. There will be then an artificial serum which will do excellently even for intravenous infusion.

The apparatus may be very simple. There are many forms on the market, some of which are excellent. In emergencies Roux's syringe (*Fig.* 41), Potain's aspirator, or the ordinary irrigator, will answer perfectly. In hospital all our injections are given with the irrigator or Roux's syringe.

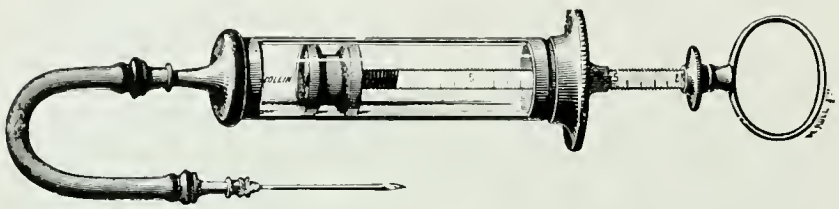

Fig. 41.—Roux's syringe.

The syringe is to be preferred only for comparatively small quantities; after injecting the first syringeful the needle is left in place and the syringe refilled as often as necessary; in this manner, without much trouble, 200 to 300 cc. (8 to 10 oz.) can be made to pass into the cellular tissue; but beyond that quantity the method becomes troublesome.

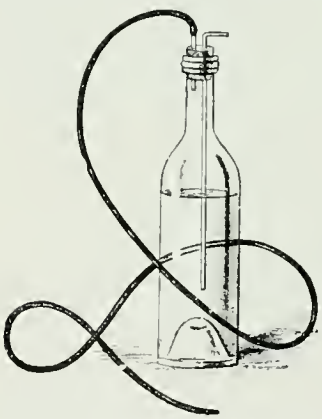

Fig. 42.—Bottle arranged for saline infusion, ready for use.

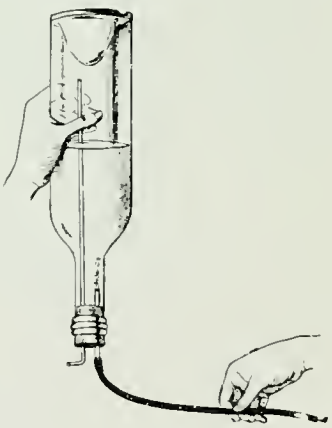

Fig. 43.—The bottle inverted; in use.

Potain's aspirator, which figures in most outfits, meets all requirements, if the various parts have been properly boiled. Varnier states that, using needle No. 2, four ounces of solution can be injected in two minutes with three strokes of the piston.

With the irrigator, sterilized in the manner previously described, a needle belonging to Potain's apparatus may be used, attached to the extremity of the tube; or for intravenous infusion, the cannula of a trocar.

or a glass cannula with a fine point. Ollivier's cannula (*Fig.* 44), which terminates in a slight enlargement obliquely cut, is excellent.

Lastly, with any sufficiently large bottle—always boiled—a cork, two pieces of glass tubing, and a length of india-rubber tube, a temporary apparatus can be improvised which will act just as well as the more elaborate forms (*Figs.* 42 *and* 43).

Fig. 44.—Ollivier's cannula for intravenous infusion.

The **subcutaneous injection** may be given into almost any part of the body, but preferably into the supero-external region of the thigh, the abdominal wall, or the inner wall of the axilla. Never omit to soap and brush the skin and to wash it with a little spirit or ether ; in emergency a

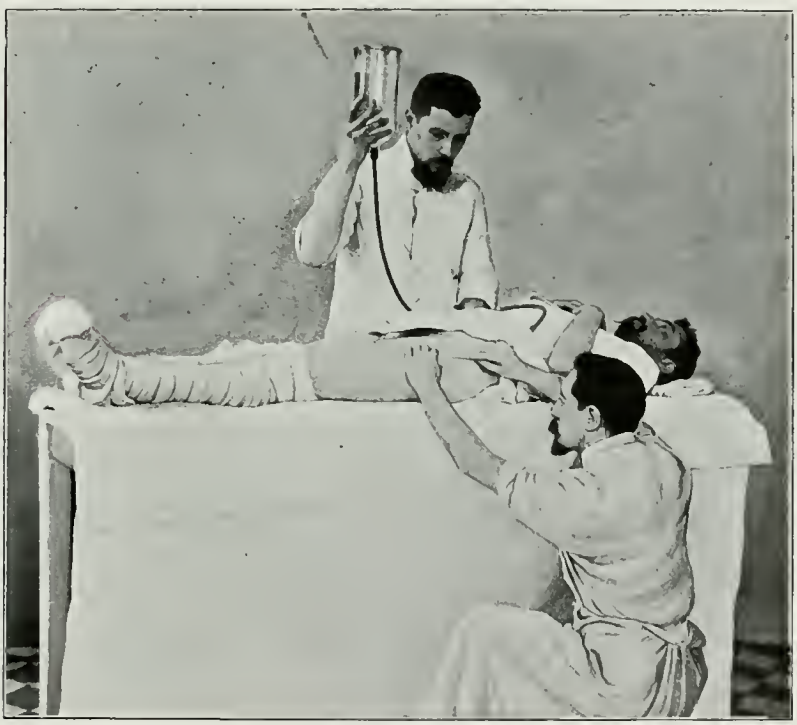

Fig. 45.—Subcutaneous infusion of normal saline solution.

good washing with boiled water—or some of the saline solution itself—will suffice. The needle should always penetrate obliquely and for a distance of one to two inches, and a little massage will assist in the absorption of the fluid.

It is usually difficult to inject more than 250 or 300 grams (8–10 oz.) at one point, both because of the tension and, more particularly, the pain, which then becomes rather severe.

The needle will now be quickly withdrawn, and, failing collodion, a little wool and a bandage will be applied over the puncture. If necessary, the process can be repeated forthwith on the opposite side. In this way quite as much fluid can be injected as by the venous route, and certainly with much less trouble. We may add that this subcutaneous method is absolutely harmless, even when very large doses are employed, that it does not produce the abrupt overfilling of the vascular system sometimes observed after direct injection into the circulation, and that, apart from the existence of far advanced and evident renal insufficiency, it causes no bad after-effects.

Fig. 46. The veins in front of the elbow

In conditions of extreme urgency, such as acute anæmia or syncope, when time is pressing and it is necessary at any cost to raise the blood-pressure quickly, **intravenous infusion** finds its indications, and it would be a mistake to exaggerate the difficulties and make a bugbear of the method. The liquid must be very warm, from 38° to 41° C. (100° to 105° F.), quite clear, and well boiled.

Potain's apparatus, or the irrigator, fitted with a glass cannula or the cannula of a small trocar, or one of the improvised forms of apparatus described above, will answer perfectly, if well sterilized.

Usually one of the veins in front of the elbow (*Fig.* 46) or one of the saphenous veins is chosen: if the vein is not visible, one need only remember that a vertical incision, internal or external to the tendon of the biceps, at the elbow, always crosses the median basilic or the median cephalic. A double ligature is passed under the exposed vessel, the lower end is tied, and the second thread, slipped higher up, is reserved for ligaturing the upper end after the operation is finished (*Fig.* 47).[1]

[1] Or, to save time, one may, as soon as the vein is exposed, seize it with a pair of pressure-forceps, open it above the forceps, and slip in the cannula. When the injection is finished, it suffices to remove the forceps and apply a little pressure over the wound by means of a pad and bandage, as after "bleeding."

Now open the vessel longitudinally for about a quarter of an inch, with the scissors or the point of the knife, and, holding one of the lips of the little venous wound with a pair of dissecting forceps, introduce the cannula, and push it in sufficiently far to plug the opening, so that a temporary ligature is not needed.[1]

The greatest care must be exercised to clear the apparatus of air before introducing the cannula, although the entrance of a few small bubbles causes no trouble. The liquid is allowed to flow in slowly, the rate being easily regulated, when using the irrigator, by raising or lowering the reservoir: two to three feet is usually sufficient. This slow entry of the fluid is of the utmost importance, especially if a considerable quantity is to be injected; too abrupt an introduction may provoke dyspnœa or angina, and may even be followed by very grave cardio-pulmonary symptoms.

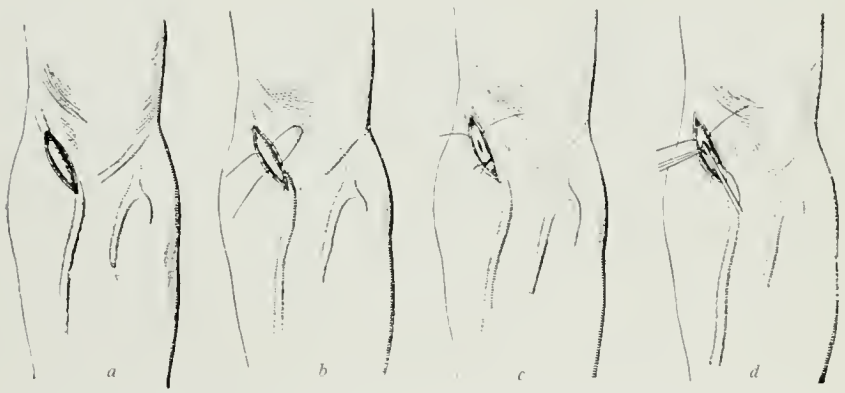

Fig. 47.—The various stages of an intravenous infusion. (*a*) Exposure of the vein. (*b*) Passing the double ligature. (*c*) Ligature of the distal end; opening the vein. (*d*) Introduction of the cannula.

From a litre to a litre and a half (2 to 3 pints) is an average dose: it is only in exceptional cases that two litres ($3\frac{1}{2}$ pints) should be exceeded.

The injection finished, the cannula is withdrawn and the upper end of the vein tied: then the small wound is bathed with some of the saline solution and closed by one or two points of suture; a sterile compress, a little pad of wool, and a bandage complete the dressing. If it should be necessary to repeat the injection after some hours, the wound may be reopened and a segment of the vein exposed a little higher up.

The intravenous method—the method of extreme urgency—should always be combined with subcutaneous injections. Further on we shall

[1] It will often simplify matters, when a vein sufficiently large has been exposed, to puncture it obliquely with one of the needles of Potain's apparatus; after the injection is given, the needle is simply withdrawn and the little wound dressed. The puncture may even be practised through the skin—properly disinfected, of course—if the vessel is sufficiently prominent. Such a proceeding, however, is not to be recommended as a general practice, for the vein is often found flattened and buried in fat, and the sharp needle is extremely likely to go right through and to bury itself in the tissues behind the vessel.

refer to the fact that peritoneal lavage often constitutes in itself a very real saline infusion, and large rectal injections can also be used with the same object.

Rectal Injections of Saline Solution—rectal enemata—are exceedingly valuable in some conditions and require only the simplest apparatus.[1]

The ordinary enema syringe will do; but to introduce the fluid with a moderate and regular pressure, and to avoid provoking rectal intolerance,[2] it is much better to use a douche-can, or a simple funnel, and an india-rubber tube, with a soft catheter attached, which is insinuated into the rectum and passed as high up as possible. The patient lies on the side, with the hips a little raised.

Boiled salt solution, with a strength of 0·9 per cent, is used,[3] at a temperature of about 37° C. (98° F.), varying from 93° F. to 102° F. according to the sensitiveness of the rectum. From half to a pint of liquid is introduced,[4] and the injection repeated, at varying intervals, up to a total quantity of four or six pints in the course of the day.[5]

Thanks to these varied channels of absorption—of which subcutaneous injection is the method of choice, the simplest and the most practical—saline infusion has almost replaced blood transfusion, with its complicated technique and doubtful efficacy.[6]

Venesection.—Indications may occur, in certain infections or in uræmia, for **bleeding supplemented by saline infusion.** The vein is exposed and incised, as for intravenous injection, a quantity of blood is allowed to escape, generally from 5 to 10 oz., then the cannula of the injection apparatus is introduced into the opening in the vein, and one or two pints of saline solution are allowed to run in.

Bleeding proper, though now rarely practised, is nevertheless very useful in certain cases: pneumonia and asphyxiating bronchopneumonia, cardio-pulmonary congestions, toxæmia, eclampsia, etc., and occasions for its use in surgery present themselves from time to time. It is sometimes employed "heroically" in those acute generalized pulmonary congestions which are occasionally seen in fat patients after operations for strangulated hernia or other conditions requiring a general anæsthetic. I remember the case of a patient who was bled five times, because of repeated attacks of asphyxia, and who, in the end, recovered.

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[1] They are, however, rather slow in action.

[2] This is, indeed, the touchstone of the method, for in some cases the rectum refuses to retain more than the smallest quantities of fluid.

[3] It is good practice to empty the rectum first of all, by means of an ordinary soap and water enema, and also to add a few drops of laudanum to the saline solution. A nutrient enema is often given after the saline injection, sufficient time, of course being allowed for absorption of the latter.

[4] Of course, if the rectum is tolerant, the quantity administered in a single dose may be considerably increased, two or three pints being introduced. This is a matter for experiment; but if the tension is much increased, an abrupt contraction of the rectum which may expel the whole quantity is always to be feared.

[5] In obstetrical hæmorrhages, in shock, etc., or given in small doses to weakly, new-born children, saline injections—4 to 8 oz. per diem—have been attended with encouraging results. (*See* Louis Lepine, *Thèse de Lyon*, 1899.)

[6] *See* Landouzy, *La sérothérapie*, p. 380–440, a masterly study of saline therapy.

Figs. 46 and 48 show the veins at the bend of the elbow, on which bleeding is usually practised: the median vein of the forearm, median cephalic and median basilic at the elbow, cephalic and basilic in the upper arm.

The median cephalic is the one usually chosen: there is nothing of importance behind it; the median basilic crosses the brachial artery more or less obliquely, but the relationship need not prevent it from being opened if it is sufficiently prominent: by palpating the artery, the point of crossing is determined beforehand, and the utmost care is taken to fix the vein properly and to make the puncture very obliquely.

In some patients the veins are large and project under the skin: bleeding then becomes very simple; but it is generally advisable first to create an obstruction to the circulation above the elbow, by rolling round the upper

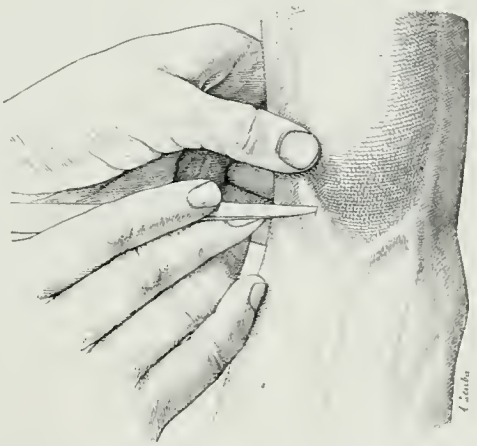


Fig. 48.—Venesection, practised on the median-cephalic vein.

arm, at its lower third, a few turns of an elastic bandage, or a simple band of linen or crêpe, tied tightly enough to arrest the venous circulation without checking the arterial flow; the two ends of the band tied in a bow, at the side of the arm (*see Fig.* 46), or secured with a pair of pressure-forceps, will permit rapid removal of the constriction.

Special instruments are unnecessary: the traditional lancet is undoubtedly convenient, but not at all indispensable. With a straight, sharp-pointed bistoury, the "bleeding" can be done quite well, with the reservation that the bistoury shall have been sterilized, that the whole region in front of the elbow shall have been cleansed with boiled water, soap, and spirit, and that the operator's hands are properly prepared.

Then, the patient's forearm resting flat on its dorsal aspect and held at the wrist by an assistant, fix the vein with the left thumb, and, holding the knife in the right hand, as shown in *Fig.* 48, puncture the vessel a little obliquely from without inwards. If there is any difficulty or danger, it is

in traversing the skin, often more resistant than had been expected, and this may, with a blunt knife, lead to some trouble; but with the skin well stretched, the vein well fixed, and a sharp point, everything goes easily. In any case do not attempt to hurry over the operation; puncture the skin and the vein, then raise the point of the knife and cut out, enlarging the opening in such a manner that the wound in the skin is of greater extent than that in the vein. The blood spurts out: turn the forearm a little outwards, and receive the jet in a vessel, the capacity of which had been previously ascertained. Should the blood not run, or merely dribble from the wound, while the skin turns dark and swells, retract and displace the lips of the little external wound, which has got out of line with the opening in the vein, sponge the wound, and make the patient move his hand and fingers.

The quantity of blood to be withdrawn is never great: 8 to 15 oz. in general. As soon as it is thought a sufficient amount has escaped, apply a thumb over the wound, pressing firmly, and have the constricting band removed. Dress it at once with a small compress folded in several layers, some wool, and a firm bandage. The limb is to be kept at rest, on a cushion.

Occasionally it is impossible, particularly in stout women, to distinguish the veins under the skin, even after prolonged compression: a cord-like structure may be felt, which ought to be the vein, and which, in an emergency, might be punctured, but it is very much better to make, on one side or the other of the biceps tendon, a short vertical incision, which necessarily crosses the median-cephalic or the median-basilic; separate the fat with dissecting forceps and director, and expose the vein, which is then incised under the guidance of the eyes.

If necessary, the internal saphenous vein at the inner surface of the tibia, or near the internal malleolus or any other prominent superficial vein may be opened, but such occurrences are quite exceptional. The same may be said of **arteriotomy**, which, under conditions of extreme urgency, may also be employed. In a woman, from whose collapsed veins no blood would flow, I opened the radial artery at the wrist. It is well, before dividing the artery, to pass a double ligature, a simple loop, above and below the point of division, so that the two ends may be tied at once after the bleeding.

SECTION II.—THE HEAD.

FRACTURES OF THE SKULL.

I.—COMPOUND FRACTURES OF THE VAULT OF THE SKULL.

A man falls on his head; he is picked up unconscious; when called, the surgeon finds him still motionless, or in that state of semi-wakefulness which succeeds the initial period of shock: the hair is impregnated with blood, and at one point on the skull is discovered an incised or lacerated wound.

Before any exploration, shave the region widely; soap it and brush it; wash it with ether or spirit and boiled saline solution. **Then only, and with well-washed hands, examine the wound.**

With some swabs soaked in boiled salt solution, wipe away the clots, the dirt of all kinds, the loose hairs; cut away at once with the scissors the torn and dirty edges of the hairy scalp. A little compression and the use of pressure-forceps will check the blood which again begins to flow. Cleanse the bottom of the wound thoroughly and examine it.

Fissure.—A linear slit runs across it, most often straight, sometimes bifurcated, and disappears under one of the edges of the wound. On touching the furrow with the finger, one can scarcely feel it; there is no yielding of the vault on either side of it: a simple fissure probably. Do not be afraid, however, of opening up the wound in the direction to which the slit in the bone extends; it may be that a little farther it changes its character, and if it be found that it *runs towards the base*, the knowledge is certainly worth the enlargement of the wound.

Suppose that the fissure is narrow, that bleeding has ceased, and no characteristic cerebral symptoms are evident: complete the cleansing of the wound, and bring the edges together with a few points of suture, but leave a mesh of aseptic gauze in the centre. That is the correct treatment; but always reserve the prognosis, especially if the patient is still suffering from concussion.

Fissures of the outer table must always cause us to suspect the existence of others, more extensive and more dangerous, of the inner table. Therefore, if the impact has been very violent, if the crack in the bone is rather wide and the edges are not level, if blood continues to flow, if hair or dirt is caught in it, do not hesitate to adopt at once the following simple and rational plan of treatment.

Never make any examination with a probe: it is an illusory and dangerous practice. **Open up the seat of fracture in order to explore**

and cleanse it. That is the treatment for every complicated fracture; when dealing with the skull it is more definitely indicated than anywhere else. A chisel and a mallet suffice. The edge of the chisel is applied to one of the margins of the fissure, very obliquely, almost parallel to the cranial surface (*Fig.* 49) and with a sharp blow a scale of the compact outer table is detached, then another, and so along the whole length of the fissure; the other edge is treated in the same manner. Enlarge and deepen the trench which has thus been made by a series of cuts, always very oblique, with the chisel, working now from without inwards. Some black blood escapes; the deep focus of fracture has been reached; it is occupied by reddish irregular fragments of the inner table. Before attempting to extract them, enlarge the opening with the chisel or the gouge-forceps, and do not be afraid of making it large; then withdraw the pieces of broken bone one by one, with the precautions which we shall indicate later, and do not forget, when the evacuation is apparently complete, to examine carefully the deep surface of the endocranium all around the opening, because these fractures of the inner table sometimes radiate to a considerable distance.

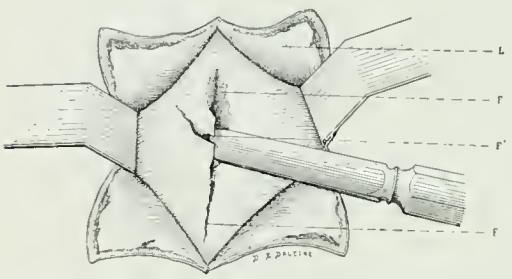


Fig. 49.—Opening up a fissure in the external table with the chisel. (L) The four flaps formed by the crucial incision, turned back. (FF') Fissure of the outer table: the chisel is applied to, and splitting off, one of the edges.

If the dura mater is intact and normal in appearance, the wound may now be closed, leaving in a small gauze drain.

In another case, under the scales and fragments of bone, the dura may be found torn and the brain exposed, or even contused and lacerated, and perhaps broken-down brain tissue mixed with clots and osseous débris escapes through the wound: cleanse the cavity gently with gauze swabs, and as before leave a gauze drain or a small tube in position when closing the wound.

In default of these measures the patient will be exposed to the onset—more or less retarded—of meningo-encephalitis or to various late and very serious troubles of which Jacksonian epilepsy is the type. The following two cases are given as examples.

Case 1.—A boy of sixteen years was standing on the top of a tramcar; his forehead came in violent contact with a railway bridge, and he fell to the ground. I saw him three hours later. He had quite recovered consciousness. There were no localizing symptoms. Above the right frontal eminence there was a little contused wound; it was enlarged; on the frontal bone, a simple vertical fissure without any depression; a thin stream of blood continued to trickle from between its lips. The fissure was enlarged with the chisel, and I exposed *a huge cavity filled with splinters of bone, clots, and broken-down brain matter, which extended deeply into the frontal lobe*; the fragments of bone were extracted, the cavity carefully cleared out with little swabs, a drainage tube

was put in, and the wound partially closed. The patient recovered without any trouble.

Case 2.—A man about thirty years of age fell on the right temple. There was a small contused wound, but no apparent depression; the wound was cleaned externally and dressed. Fifteen days later, febrile symptoms, nocturnal delirium; the wound was opened up, and a simple fissure of the cranium was found, but the mallet and chisel quickly showed that *extensive splintering of the inner table* had occurred, and laid bare numerous detached scales of bone bathed in pus. The dura mater was intact. After careful cleansing of the cavity the threatening symptoms disappeared.

Comminuted Fracture with or without Depression.—If it is over the Rolandic area or one of the cortical centres, some of the symptoms termed "focal" or "localizing" may be observed: paralysis or contracture, aphasia, etc. If the patient is still in a state of concussion and completely unconscious, or if the injury has acted on the latent zones of the cortex, any indications of this kind will naturally be wanting. But we do not need such focal symptoms to justify immediate action: we must never wait for them.

In a complicated fracture of the skull it is necessary to intervene at once, to remove loose fragments of bone, and to disinfect it: such is the rule, very simple, but permitting neither exception nor reservation. The wound is enlarged—after the usual preliminaries—and the fracture freely exposed.

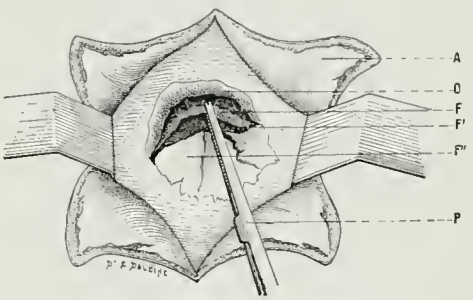


Fig. 50.—Extracting the deep splinters of the internal table with the forceps. (A) Flaps, turned back. (O) Border of the opening in the outer table, from which some of the superficial splinters have just been removed. (F' F'') Superficial splinters, triangular, depressed at the apices. (F) Deep splinter; extensive splintering of the inner table. (P) Kocher's forceps, which have seized the deep splinter by the middle, and are trying to disengage and extract it by horizontal traction, without tilting.

Not uncommonly — and what we are about to say will apply equally to other varieties —the fragments, triangular and grouped in a star, remain joined together, forming, on the outer surface of the skull, a cone of depression, of varying depth, on the inner surface a projecting cone.

Try to raise by one of its edges the fragment which appears to be most detached and most movable: it is seldom that the blade of an elevator or a chisel cannot be insinuated underneath it; free it bit by bit all round and remove it (*see Fig.* 56). If necessary a gentle blow with the mallet will make the chisel slip into the fissure between the fragments, or if it is too tightly fixed, the fragment may be attacked from without inwards by freeing its base with the chisel.

After the first piece is removed the others are easily dealt with. They can be seized by the edge, one by one, with forceps, and extracted by means of traction, always in a line parallel with the cranial surface, or raised *en bloc* with an elevator or by means of a chisel introduced on the flat. This is the layer of superficial splinters.

Below will be found the layer of **deep fragments**, those of the internal table, adherent to the dura mater, more numerous, radiating more widely, and always more difficult to extract (*Fig.* 50).

If we take hold of one of these deep splinters by one of its extremities and try to lift it, a see-saw movement results, the opposite extremity is depressed, and compresses or perhaps lacerates the brain. Seize them, therefore, transversely, about the middle, and, while raising gently, separate the underlying dura mater with a curved rugine (*Fig.* 51) or a director; **never try to tear them out.** Beyond the edge of the cranial orifice other scales of the inner table show themselves; **by perfectly horizontal traction** try to loosen and disengage them (*Fig.* 50); if there is the least difficulty in carrying out this manœuvre, make more room with the gouge-forceps (*Fig.* 53). The extraction of these endocranial scales is of the utmost importance for future recovery; the greatest care must therefore be taken to remove them all. In these comminuted fractures one would never think of simply raising the fragments and leaving them in place.

Fig. 51.—Curved rugine.

When the depression is considerable, the locking of the broken pieces is sometimes so close that it is impossible to get an instrument between them. Do not persist, but take the chisel and free the circumference of the depressed zone, or bore one or two holes just outside the border: they will then be easily raised. (*Fig.* 52).

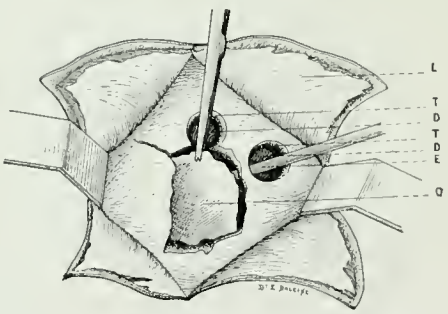


Fig. 52.—Raising an imprisoned fragment. (L) Scalp flaps. (O) Imprisoned fragment. (TT) Two holes bored at the margin of the breach. (DD) Dura mater, seen through the openings. (E) Elevator raising the fragment, which is fixed by a pair of forceps applied to one of its borders.

Depression of a Large Fragment.—It is particularly in this condition that the above plan finds its application. A large fragment of the vault, often quadrangular, is detached all round and completely depressed below the level of the surrounding bone (*Fig.* 52). At first sight it appears quite simple to introduce a thin blade—the end of a curved rugine or of a director—under the depressed plaque, and to lever it out; but this very rarely succeeds, and tilting of the fragment may damage the brain.

If the interval between the depressed bone and the surrounding skull is wide enough, one may be able to extend one of the borders of the opening with the gouge-forceps (*Fig.* 53) sufficiently to permit of **horizontal extraction.** Often, however, there is not sufficient room for the use of the gouge-forceps, and then it is best to employ the method shown in

Fig. 52.[1] Opposite the middle of one of the margins, and a little distance outside it, a first hole is bored; on the opposite, or on the adjacent side, a second, the latter encroaching on the breach: it is then quite easy to **raise the fragment** without any risk of canting it and possibly damaging the brain: the fragment is caught at one side with a pair of forceps, which fixes it, while with an elevator slipped underneath it is freed and lifted out.

Must our action be limited simply to *raising* the fragment? Yes, if it is very large, or if it is still attached to the vault by one of its borders and we can keep it in good position; if necessary, we may cut a piece out of one side to facilitate the cleaning and draining of the underlying area. But if it is completely detached all round, elevation pure and simple will often be unsatisfactory: the fragment will fall back and again cause compression, and later it may necrose. Remove it, therefore, and remember that, excluding some cases where there has been considerable loss of tissue, hernia cerebri is almost invariably due to inflammatory causes, and that asepsis is the best means of preventing it.

When the fragments have been removed and the underlying area cleared out, if the dura mater is intact or simply abraded, if nothing in its appearance causes us to suspect the existence of an underlying effusion of blood, the operation will be completed in the manner previously indicated.

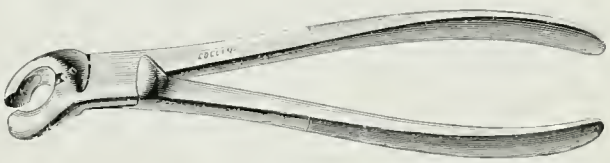


Fig. 53.—Curved gouge-forceps.

But possibly, on the extraction of the depressed fragments, profuse hæmorrhage appears: this bleeding may come from the diploë, from a meningeal artery, from a sinus, or if the dura mater is torn and the brain injured, from the vessels of the pia mater. The seat of the fracture will itself furnish some presumptive evidence as to the source of hæmorrhage.

Without haste, plug the cavity with an aseptic compress: then, **gently raising the plug, working steadily from one edge**, endeavour to find the source of the bleeding.

A little pressure is usually sufficient to check any bleeding from the diploë: if any point in the cut margin of the bone continues to leak, however, a nip with a pair of lion forceps or the gouge-forceps will easily set it right. If the blood comes from the depths of the wound, place a finger on the bleeding spot and try to compress it, from within outwards, against the inner surface of the skull. Further on we shall see how bleeding from the middle meningeal artery or its branches is to be dealt with.

Pressure-forceps cannot be employed satisfactorily on the friable walls of the venous sinuses; if a sinus is involved[2] and the gaping wound can be seen, occlude it with the finger, sponge away the blood, and try to pass

[1] See further on for a description of the method of perforating the skull with the burr; the openings may also be made with a small trephine or, if necessary, with gouge and mallet.

[2] It is, most often, the superior longitudinal sinus.

a ligature with a curved needle through the dura mater and around the sinus; if successful, then the ligature must be tightened very slowly and cautiously, or it will tear through the tissues.

When the size and seat of the opening in the sinus will allow it, a *lateral suture* of catgut or silk, with a fine needle and a fine thread, is good practice, especially for the large sinuses, as the blood channel is not obliterated.[1] But plugging is often the surest or only possible method. Take some heavy catgut, and introduce it into the cavity of the sinus with forceps—**several yards of the catgut** will be needed—and pack it in firmly until all bleeding has stopped.[2]

Lastly, it may be impossible to find the source of the bleeding, or there may be nothing which can be caught with forceps, or ligature, or plug—a condition of affairs not uncommon in hæmorrhage of cortical origin, as the vessels of the pia mater break on the slightest traction—gauze packing then remains the only available resource, but a valuable one if well done with long strips of aseptic gauze, packed into the cavity with the aid of a pair of forceps.

Sometimes, under the fragments of bone, will be found a large clot, extradural or intradural; we shall see later how this is to be dealt with.

Crushing Fractures.—An enormous segment, perhaps half of the vault, is broken into multiple fragments, numerous fissures radiate towards the base. These are very grave cases, almost always hopeless.

Case 3.—A man, a patient in La Pitié, had just fallen from the third floor: he was comatose, and the limbs were flaccid. There was a large wound on the vertex and the right temple. The whole vault of the skull crepitated; it was broken into many fragments; through a large fissure at the vertex the blood ran in a profuse stream, soaking the first dressing, pillow, and sheets. By the extraction of some of the adjacent fragments the superior longitudinal sinus was rapidly exposed: it was bleeding in a jet like a large artery. The sinus was plugged with catgut, and the wound cleansed and packed with gauze. The hæmorrhage ceased, but the man died some hours after.

Whatever may be the probability of a fatal issue, these onerous tasks must not be shirked, and all that is necessary for **checking hæmorrhage, disinfecting the area, and rectifying the more considerable depressions** must be done.

It is necessary to guard against too free removal of the detached fragments of bone, which come away on the slightest traction, and so readily that the brain may very easily be denuded of a large part of its bony covering.

[1] Schwartz. "Suture of veins, with particular reference to a case of suture of the lateral sinus, torn during an operation for depressed fracture of the skull" (*Congrès français de chirurgie*, 1896, p. 263). The wound in the sinus, which was about half an inch long, was closed by two sutures of No. 0 silk, and as blood continued to escape by the suture holes, gauze was packed down to the sutured sinus and a compressive dressing applied. Recovery. See also the thesis of Georges Luys, "Des blessures des sinus de la dure-mère" (Paris, 1900); and further on, under the heading of "Wounds and ruptures of the great vessels," for the technique of suture of veins.

[2] This plugging is permanent: it is not touched again, but is gradually absorbed. The same result can be obtained by tight plugging with aseptic gauze, in which case the plug must be left in the vessel as long as possible—10 to 12 days.

II.—SIMPLE FRACTURE OF THE VAULT OF THE SKULL.

The clinical possibilities may be divided as follows: (1) *There is a local sign on the cranial surface, but no focal cerebral symptoms;* (2) *There is a local sign, and also focal cerebral symptoms;* (3) *There are focal cerebral symptoms, but no local sign.*

1. A Local Sign; no Focal Symptoms.

The patient is still unconscious, motionless, in the "state of concussion." Look if there is any bleeding from the nose or ears; have the hair cut, and carefully examine the cranial vault to determine if there is any scratch, bruise, or other superficial mark of direct injury, or if there is any area of depression or an appreciable fissure. Whatever may be the result of this first examination, unless a considerable depression exists over the Rolandic area, there is no indication for immediate operative treatment, but a careful watch must be kept for the possible development of any characteristic symptoms.

Unconsciousness passes off, giving place to a condition of mental dullness; all the limbs can be moved at will; there is no irregularity of the face, speech is slow but correct. In short, there are no focal symptoms.

If there is only found on the vault or side of the skull a painful spot or fissure, then there is nothing to be done. If, however, a definite depression is discovered, the question is open to discussion.

The usual practice is: **no external wound, no symptoms, no operation.** It is not advisable to lay on the practitioner a responsibility which, after all, he will not take, and indeed *ought not to take*; but it is none the less true that, if the conditions permit of it being done well, the immediate opening up of the seat of fracture, and the elevation or extraction of the depressed fragments, is the ideal treatment, which will anticipate the possible development of late complications and prevent the necessity for subsequent trephining.

2. A Local Sign with Focal Symptoms.

There must be no hesitation when symptoms of **cerebral compression** are associated with a **local cranial sign.**

We discover a right hemiplegia, a monoplegia of the right upper or right lower limb, a paralysis of the lower segment of the right side of the face, aphasia; and the examination of the cranium has disclosed a depression on the left side, over the Rolandic area, a crepitating fracture, etc.: nothing could be more definite: it is necessary to **open the skull,** on the left side, **at the seat of fracture, the local sign,** leaving the subsequent steps of the operation to be determined by the conditions discovered.

The compression is due to one or other of two factors: **Depressed Bone, or Effused Blood.** We have considered the methods of dealing with the former; we shall see presently how an intracranial hæmorrhage is to be treated.

Apart from those cases, which are, on the whole, simple, where the

paralytic symptoms, of varying and often steadily increasing intensity, correspond with the position of the injury of the skull, it is useful to mention certain apparent anomalies, somewhat bewildering, but which are easily explained when analysed :—

(*a*). There is **no correlation between the seat of the fracture and the peripheral symptoms observed :** the fracture is on the right side of the vault ; it is also on the right side that a hemiplegia is discovered.

The mechanism of *contre-coup* explains these facts. On the side opposite to that which received the impact and which bears the sign of injury, there is an effusion of blood or an area of cerebral contusion. What is to be done? In the first place proceed to the fracture, the local sign: open it up, extract or elevate the fragments, and evacuate the subcranial focus ; this action will often furnish important information, which may render further operation needless. If not, it will be necessary to trephine over the cerebral areas indicated by the paralytic or convulsive symptoms.

(*b*). Fracture of the vault on the left side, right hemiplegia, left-sided facial paralysis, or the inverse formula : to put it shortly, there is **facial paralysis on the same side as the fracture of the vault.** This indicates the existence of a *fissure radiating towards the base, into the petrous portion of the temporal bone.*

Intervention at the seat of depression is not less indicated ; but the prognosis is much graver, owing to this undeniable evidence of a basal fracture.

(*c*). **The symptoms may be associated in a fashion still more complex, and without any correlation with the evident cranial lesion.** These disseminated, diffuse, irregular symptoms—paralysis, contractures, localized epileptiform convulsions—originate in multiple areas of cerebral contusion. The prognosis depends on the number and severity of the lesions and also on their ultimate evolution, and will therefore always be doubtful. There is no reason for operative interference.

3. No Local Sign, but Focal Symptoms.

We shall consider first of all the typical cerebral compression, due to extravasation of blood from a ruptured middle meningeal artery, and afterwards some more localized compressions.

(*A*). **LARGE EXTRAVASATION OF BLOOD**—intra- or extra-dural.—The patient was seen shortly after the injury, when he was just emerging from the period of initial stupor ; there was no trace of any paralysis. Some hours later a hemiplegia has developed, slowly but steadily ; the patient is once more unconscious, the respiration is stertorous, the pulse slow and full ; on the side opposite to the hemiplegia the pupil is dilated and immobile, and there is also an **œdematous infiltration of the scalp in the temporo-parietal region.** We must recognize the existence of an intracranial extravasation of blood and the urgent necessity for relieving pressure on the brain and checking the bleeding.

Often, a close examination of the temporo-parietal region will reveal some local sign—a fissure, a point which yields under the finger, or to pressure on which the patient still vaguely responds. Such a sign is always of the greatest value, and indicates the spot where to trephine.

Presuming, however, that nothing is found to serve as a guide: before operating, always recall **the topography of the two branches of the middle meningeal artery.**

The whole side of the head is shaved. With the finger feel the zygomatic arch, the inferior border of the orbit—always recognizable in spite of the œdema of the eyelid,—the external auditory meatus; join these three points by a line, with the aid of a skin pencil or tincture of iodine, or simply by depressing the skin with the finger-nail or a blunt point: that is the *inferior horizontal of the cranium*, the base line.

From the upper border of the orbit draw a second line, parallel to the first, and prolong it backwards beyond the ear: that is *the superior horizontal*.

Fig. 54.—Site of the middle meningeal artery. A horizontal line is drawn along the zygoma, from the external auditory meatus behind, to the inferior border of the orbit in front. A perpendicular, 2 in. long, erected on this line at the middle of the zygomatic arch, indicates the point sought. On the sagittal line are marked, in front, the bregma; and behind, the superior Rolandic point.

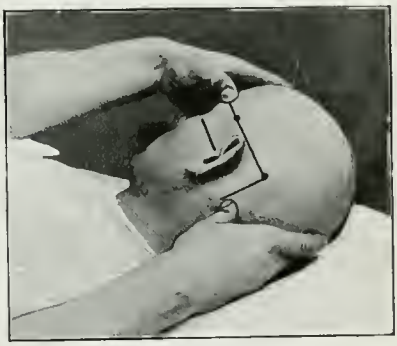


Fig. 55.—Sites of the middle meningeal artery and its posterior branch. Below, along the zygoma, the inferior horizontal line. Above, parallel to the preceding, the superior horizontal line. On the latter, the anterior point marks the position of the middle meningeal (2 in. above the zygomatic arch); the posterior point the position of the posterior branch.

With a visiting card, a ruler, or any suitable straight-edge, erect a perpendicular on the inferior horizontal at the middle of the zygomatic arch; measure off 2 in.—approximately the length of the two distal phalanges of the index finger—on this perpendicular (*Fig.* 54); we are on the position of the middle meningeal artery (Poirier). Further, notice that this point is where the perpendicular meets the superior horizontal. Finally, this same point corresponds to the *antero-inferior angle of the parietal bone*, which will presently become evident at the bottom of the wound.

Next, draw *a second perpendicular, touching the posterior border of the mastoid process:* the point where it meets the superior horizontal marks the position of the posterior branch of the middle meningeal artery (Krönlein) (*Fig.* 55).

Trephining is not a mathematical operation : the opening in the skull should be large, and should expose endocranial areas, rather than precise points ; but it is always well nevertheless to define the position before operating.

The patient is now anæsthetized, unless he is in a state of coma, when, of course, an anæsthetic would be useless. Chloroform is to be preferred to ether, which causes cerebral congestion. The head being fixed in a convenient position, a horse-shoe flap is marked out about two inches wide, convex side upwards, with the base just above and parallel to the zygomatic arch. Cut through the scalp with the first incision, then with another, made close to the edge of the retracted skin, divide the periosteum down to the bone. Do not stop to pick up the spouting arteries ; take the elevator, strip up the periosteum rapidly, and turn the flap down in one piece ; some pairs of Kocher's forceps, a little pressure, or a few ligatures passed with a curved needle, quickly check the bleeding. The bone is exposed : very often we find a fracture, a fissure, or a small depression, which had escaped the external examination ; there we must open the skull.

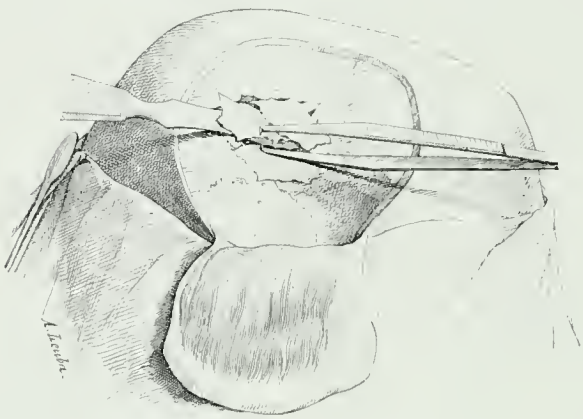


Fig. 56. Trephining at the seat of fracture. Method of raising and extracting the fragments.

Trephining at the Seat of Fracture.—The method to be followed in opening the skull at the seat of fracture varies with the nature of the bone lesion.

If the fragments overlap a little—if one of them even projects sufficiently to allow of an elevator being slipped underneath and one of its edges being gripped with a pair of forceps (*Fig.* 56)—we can proceed to extract them one by one, without tilting, in the manner already described (see pp. 47–49), by horizontal traction ; after which, if necessary, the opening may be enlarged by means of the gouge-forceps (*Fig.* 57).

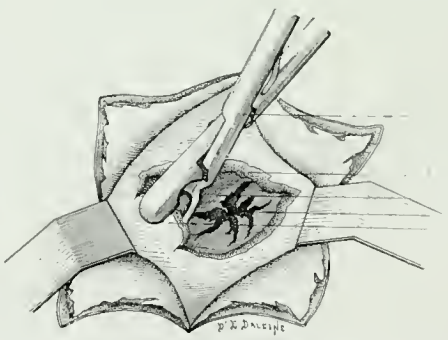


Fig. 57.—Enlarging the opening in the cranium with the gouge-forceps. (C) Gouge-forceps. (A) Retracted flap. (O) Margin of the opening in the bone. (D) Dura mater. (P) Tear in the dura mater. (E) Gouge-forceps nibbling away the edges of the opening.

A star fracture may be found, a little depressed at the centre, but with the pieces tightly locked together, and presenting no opening for direct attack. The best plan then will be to bore an opening a little outside the depressed area, cut away the small intervening bridge of bone with the gouge-forceps, and then to attack one of the fragments by its base (*Fig.* 58); after that has been removed there will usually be very little difficulty in dealing with the rest of the depressed bone, but if need be, two or three more openings may be made. These openings in the intact bone can, in an emergency, be cut with a gouge (*Fig.* 59) and mallet: the lack of a trephine or other special instrument can never justify a refusal to undertake an urgently necessary operation.

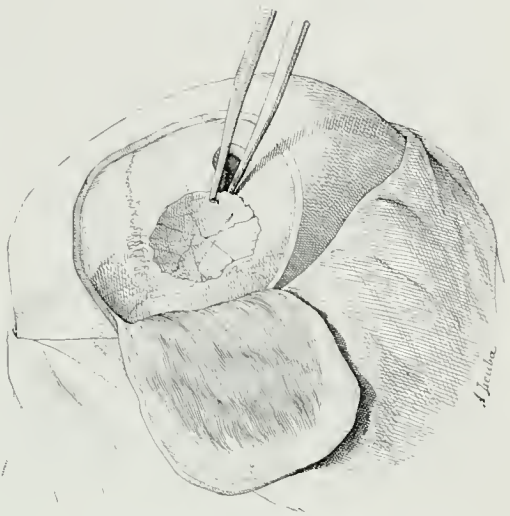


Fig. 58.—Trephining at the seat of fracture. Star fracture: method of attacking and detaching the fragments.

Working from without inwards, using the gouge very obliquely, a disc of bone about an inch in diameter is gradually cut away: having traversed the diploë, a little sharp blow, delivered very obliquely, will remove

Fig. 59.—Trelat's straight gouge.

a scale of the inner table, and once the breach has been made it is a comparatively simple matter to enlarge it with the gouge or the gouge-forceps. The division of

Fig. 61.—Burr, 8 millimetres diameter (Doyen).

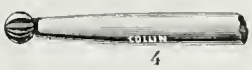


Fig. 62.—Burr, 4 millimetres diameter (Doyen).

Fig. 60.—Brace armed with perforator (Doyen).

the inner table is the dangerous stage; in these cases, however, the risk is markedly lessened by the frequent presence within the skull of a thick layer of blood-clot.

The method must never be used except in conditions of extreme necessity, as, apart altogether from the question of danger, the hammering of the skull, especially when fractured, is not a matter of indifference.

The usual method consists in perforating the cranium by means of a **burr** or a **trephine**. The operator should provide himself by preference with Doyen's burrs (*Figs.* 61 and 62) fitted to a brace: they are quite as easy to use as the crown trephine, and with a little practice one can work well and rapidly with them.

Arm the brace first of all with the perforator (*Fig.* 60), apply the point **vertically** to the surface of the cranium, hold and press upon the butt with the left hand (of course, without applying it to chest or chin), and begin to bore with the right hand.

The thickness of the skull is not known: therefore stop as soon as a depth of an eighth of an inch has been penetrated. Replace the perforator by a burr of 16 mm. ($\frac{2}{3}$ in.), and continue the boring after introducing the summit of the burr into the hole which has been just made; employed in this way, the burr does not slip, and bites at once. Be careful, first, to keep the brace constantly **at right angles to the surface of the skull**; second, to exercise a steady pressure on the butt.

Fig. 63.—Using the circular trephine, fitted to a brace.

As soon as it enters the diploë, the burr begins to throw out a soft bleeding pulp; this pulp tends to clog the cutting edges of the tool, which may have to be withdrawn and cleaned. When the inner table is reached and the perforation nearly complete, the instrument will be felt to bite more strongly and the bony chips become more abundant. Now relax the pressure on the handle and withdraw the instrument; take a probe, and explore the bottom of the hole: if not quite through, reapply the burr and proceed cautiously. As the rounded end of the burr, however, pushes the dura mater before it, and does not tend to penetrate, with a very little care all danger can be avoided.

In my opinion, this is the instrument best suited to the requirements of urgent cranial surgery. If, however, only a circular trephine is available, proceed as follows:—

Take a trephine of an inch diameter, make the centre-pin project about

an eighth of an inch, and fix it securely; then apply the point to the centre of the area to be trephined, and bore into the bone until the crown has cut a circular groove. Now withdraw the instrument, pull the centre-pin up, and fix the guard at about a quarter of an inch from the edge of the teeth. The crown is now replaced in its groove and the rotary movement resumed, care being exercised to keep the instrument at right angles to the cranial surface (*Fig.* 63), otherwise the crown bites more deeply on one side than on the other, the cut becomes oblique, there is danger of injuring the dura mater, and further, the movement of the instrument is impeded. From time to time the instrument is withdrawn, the teeth are cleaned, the depth of the fissure is ascertained with a probe, and attempts are made to loosen the disc of bone.

This is the difficult stage: the more regular and uniform the bone section in all its extent, the less difficult will it be. An elevator, insinuated into the groove, will serve to lever out the disc.

Fig. 64.—Gauge for measuring the thickness of the cranium (Doyen).

It may be, however, that no fracture is found on the exposed temporo-parietal surface; advantage can then be taken of the anatomical landmarks previously mentioned to trephine over the antero-inferior angle of the parietal bone, at two good finger breadths above the middle of the zygoma[1]; but it is always better to cut a fairly large trap-door in the skull, and thus provide at once sufficient room.

Trap-door Trephining.—To do this, first bore a hole in the manner already recommended; often some dark blood escapes from the opening, and at the bottom a blackish mass of blood-clot is visible. However that may be, bore another hole, an inch above and behind the first; this time one can work much more quickly if care has been taken to ascertain the thickness of the skull at the first orifice, by means of Doyen's gauge (*Figs.* 64 and 65): I presume that blood-clot has again been reached. If so, then make a third and perhaps a fourth orifice, which will form with the first pair the three angles of a triangle, or the four corners of a square. After joining them the whole segment of bone can be lifted out.

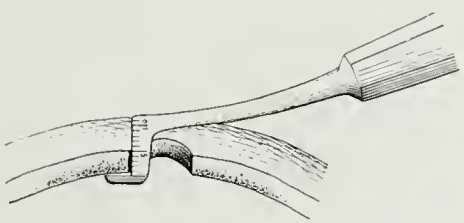


Fig. 65.—Measuring the thickness of the cranium through the first hole bored.

[1] Or again, if at this spot the dura mater is found intact, with no blood, no clots, then bore a second hole, a little more posteriorly, and if nothing is found, proceed to the posterior seat of election, at the junction of the superior horizontal and the perpendicular touching the posterior border of the mastoid process (*Fig.* 55), and there trephine afresh: one will sometimes come down upon a posterior extradural hæmatoma, which must be dealt with in the manner presently to be described.

If the circular trephine is employed, act in a similar manner by cutting out three or four discs of bone at the angles of the segment to be removed.

When the skull is thin, the holes can be quickly connected by means of the craniotome (*Fig.* 66); if it is thick, the intervening bridges of bone can be cut with the guarded chisel (*Figs.* 67 and 68); no special instrument is necessary, however; an ordinary chisel will answer quite well if carefully used, in a line almost parallel to the cranial surface. Lastly, Gigli's saw, well handled, is an excellent tool for the purpose: *Figs.* 69, 70, and 71 show how it is to be used. Pass one of the ends from one hole to the next, between the dura mater and the skull; when the end appears at the bottom of the second hole, pick it up with a pair of Kocher's forceps and draw it gently outwards (*Fig.* 69). Attach the two handles and proceed to saw, holding the wire as nearly as possible in a straight line (*Fig.* 70) at first, but curving it a very little as the cut deepens. Repeat the same procedure between the other openings. Below, the two lower holes are usually joined by a cut with a chisel (*Fig.* 71).

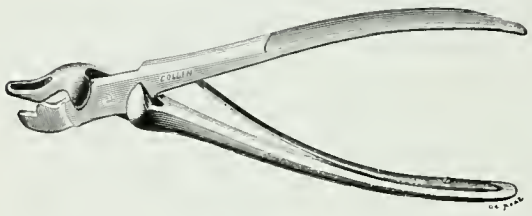


Fig. 66.—Doyen's craniotome.

Fig. 67.—Doyen's guarded chisel.

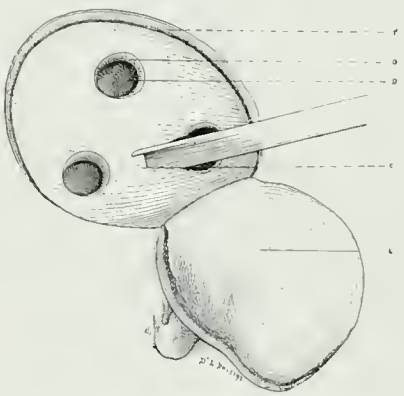
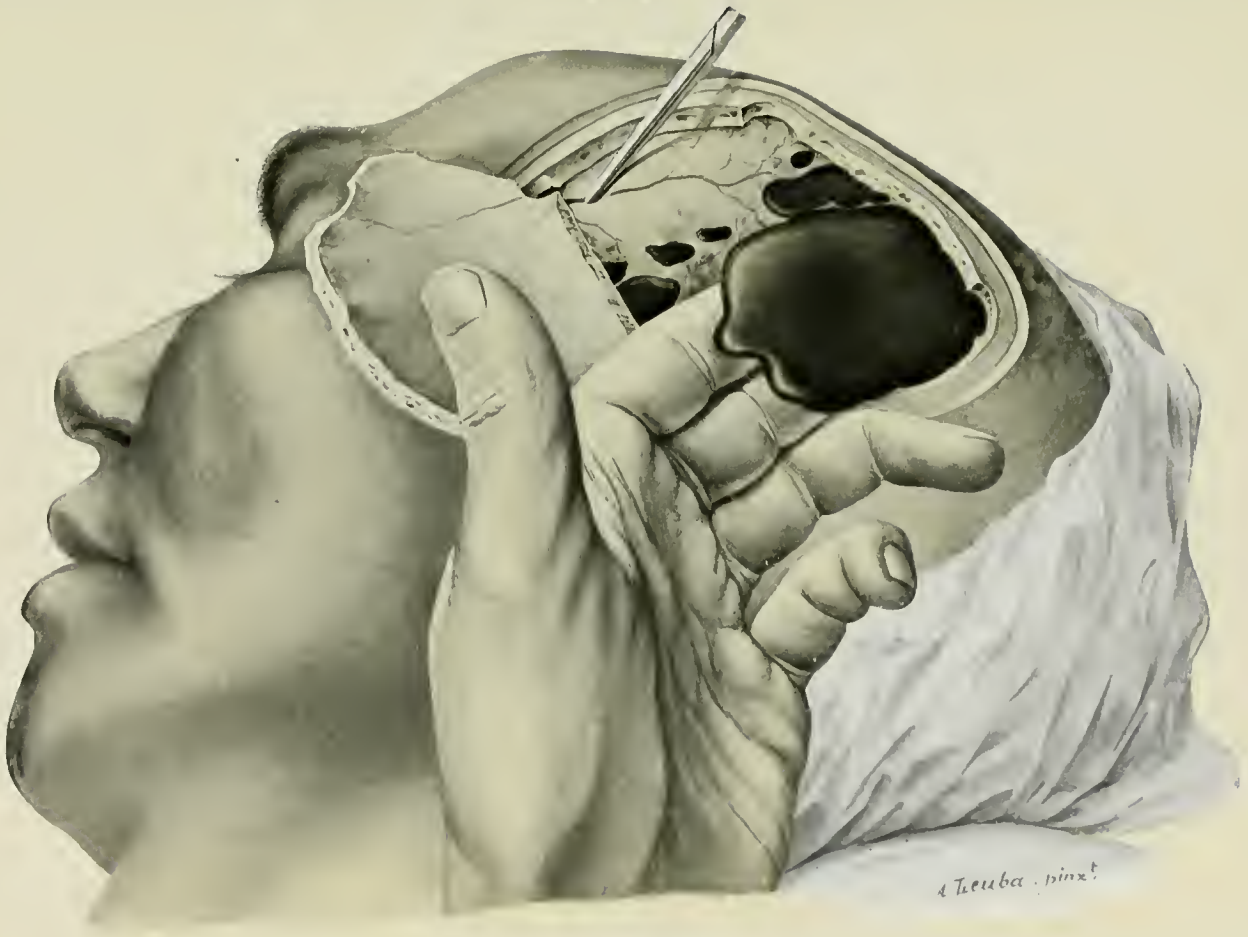


Fig. 68.—Joining with the chisel the holes bored in the skull. (P) skin. (O) Margin of one of the holes. (D) Dura mater. (C) Chisel dividing the bridge of bone between two adjoining holes. (L) Scalp flap turned down.

Lastly, if the bone is intact—and if the operator has had previous experience with the method—**osteoplastic craniectomy** may be adopted; by cutting a large osteocutaneous flap, which is turned down and subsequently replaced, very free access is provided without any permanent loss of substance.

An incision, going down to the bone, marks out a horse-shoe flap, convex side upwards, with a pedicle, at least two inches broad, attached just above the zygoma: some holes are made with the burr or the circular trephine (3, 4, or 5, according to the size of the flap), of which the first and the last mark the two borders, anterior and posterior, of the pedicle; the bridges of bone between the various holes are divided, except that between the two holes

PLATE I.



TREPHINING FOR INTRACRANIAL HÆMORRHAGE

on either side of the pedicle ;[1] this will serve as a hinge, and is broken horizontally. A blow with a chisel from behind forwards (see *Fig. 71*), another from before backwards, begins the fissure ; it is completed by raising the flap with a curved rugine, introduced under its convex border (see *Plate I*).

After the intracranial part of the operation is over, the flap is raised and replaced like a door, the cut edges of bone being engaged and adjusted as closely as possible ; one of the lower holes, enlarged if necessary, will serve for the passage of a drainage tube.

The extradural hæmatoma is exposed.

Remove the larger clots with the fingers and break up the often compact mass ; the smaller clots occupying the extremities of the cavity

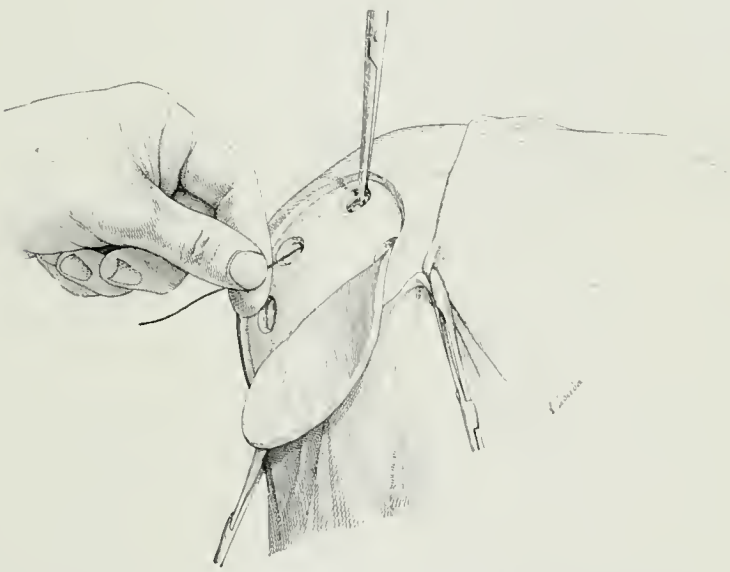


Fig. 69.—Joining the holes in the skull by means of the Gigli saw. Passing the saw from one hole to another.

are gently scraped away with a blunt curette, and some little swabs held in forceps do the rest. Examine the cavity well, especially *behind and below*, the directions in which the extravasation mostly extends.

The cavity being now empty, the brain, released from pressure, commences to expand, and the dura mater returns to its place and begins to

[1] The bone section ought to be bevelled as much as possible, so that the margin of the bone flap shall, after reposition, rest upon, and not slip below, the level of the margin of the opening ; a good plan, following the example of Doyen, is to reserve two bony bridges, one in front and one behind, which are not cut like the others, but are broken after having been cracked, like the pedicle.

Plate I.—**Trephining for intracranial hæmorrhage.** Osteoplastic craniectomy : the flap is turned down after fracture of the pedicle ; extradural hæmatoma being removed with the fingers ; in front, pressure-forceps are applied to the ruptured middle meningeal artery.

pulsate; nothing bleeds; all is finished. A small strip of aseptic gauze may perhaps be left in the mouth of the cranial opening and an end

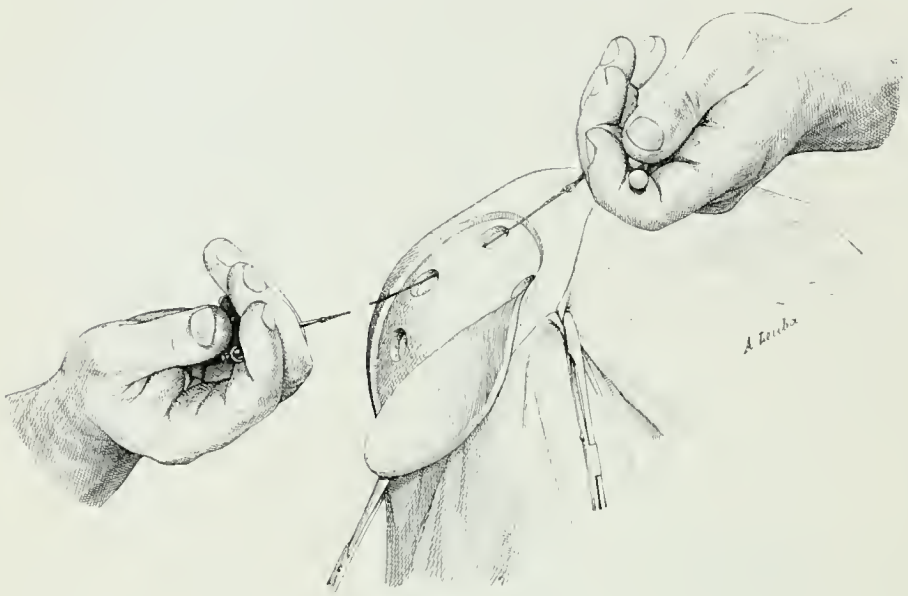


Fig. 70.—Joining the holes in the skull by means of the Gigli saw. Sawing the bridge of bone.

brought out at one of the angles of the incision; the flap is now replaced and sutured in position.

At other times bright red clots are found, soft and diffluent; the

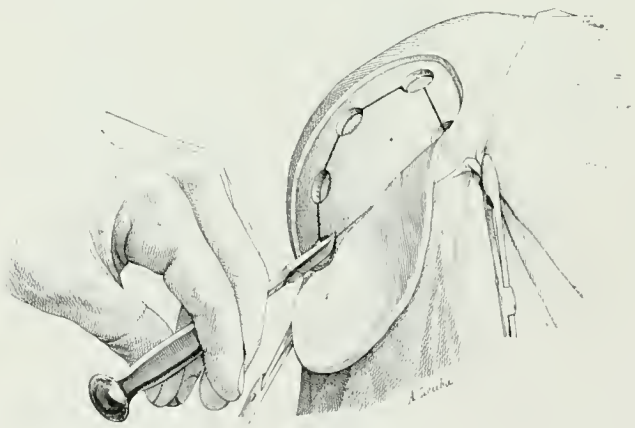


Fig. 71.—Dividing with the chisel the bridge of bone between the two lower holes.

bleeding must then be expected to recommence as soon as the large mass has been removed.

Commonly, it is from below and in front that an abundant hæmorrhage comes; sponge the blood up quickly and place a finger on the bleeding point; perhaps a jet may be seen, and it may be possible to apply pressure-forceps to the spouting vessel in the dura mater; do not attempt to apply a ligature over the forceps in the ordinary manner: the thread will refuse to slip over the jaws at the depth in which we are working, and if pulled, even gently, the forceps will come away in our hands, tearing artery and membrane.

The best plan is to pass a ligature with a curved needle beyond the forceps, in and out of the dura mater, and under the vessel, as shown in *Fig.* 72. Tighten the ligature very gently, or it will cut out. If this plan is impossible, then nothing can be done but leave the pressure-forceps on the vessel and pack the cavity. In the case of a patient on whom I operated some hours after an accident, I removed an enormous mass of soft clot, and then found that I had to deal with serious hæmorrhage. The dura mater was very badly torn; all the ligatures cut out; I packed the cavity, which at first seemed satisfactory, but soon the blood soaked through; I removed the gauze, picked up a bleeding point, and left the forceps in position. The hæmorrhage ceased.

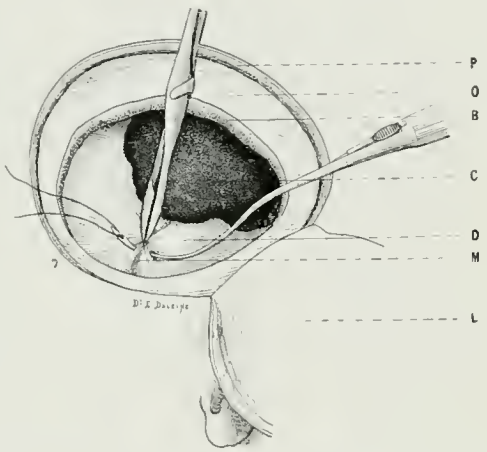


Fig. 72. – Extradural hæmatoma; ligaturing the ruptured middle meningeal artery. (P) Skin incision. (O) Denuded cranium. (B) Margin of the opening in the bone. (C) Extradural hæmatoma. (D) Dura mater depressed by the hæmatoma. (M) Middle meningeal artery, caught by pressure-forceps and gently raised, while a curved Reverdin needle is passed through the dura mater, below it. (L) Flap turned down.

In these conditions it is necessary to work quietly and methodically: to pack one part of the cavity in order to better examine another part, to endeavour to pick up **everything that bleeds**, without troubling too much to know exactly **what bleeds**. Indeed, even in the most definite cases of extradural hæmatoma, it is not always the middle meningeal artery which is the source of the hæmorrhage; sometimes it is one of the accompanying veins, or it may be some other meningeal vein, or a vein or artery of the cerebral cortex. Gauze packing remains as a valuable resource if it is well done.[1]

Such is the typical operation in cases of intracranial hæmorrhage, an operation the benefits of which are sometimes immediate: as soon as the accumulation is evacuated and the brain relieved from pressure, stertor

[1] If hæmostasis cannot be produced at the seat of bleeding, and red blood continues to flow in abundance, the external carotid should be ligatured.

ceases, consciousness and motor power begin to return, and that often with the precision of an experiment.[1]

But there are other possibilities which it is well to remember.

Subdural Hæmatoma.—The skull has been opened in the region indicated; there is no extradural extravasation, but the dura mater is tense, without pulsation, blackish or greenish, and bulges into the opening. These signs are suggestive of a collection of blood below it; should this be so, a little incision with the point of the knife will confirm the suspicion. *The hæmatoma is subdural.*

Open the dura mater by cutting a flap, base upwards, with the edge about a quarter of an inch from the margin of the opening in the bone (*Fig. 73*).

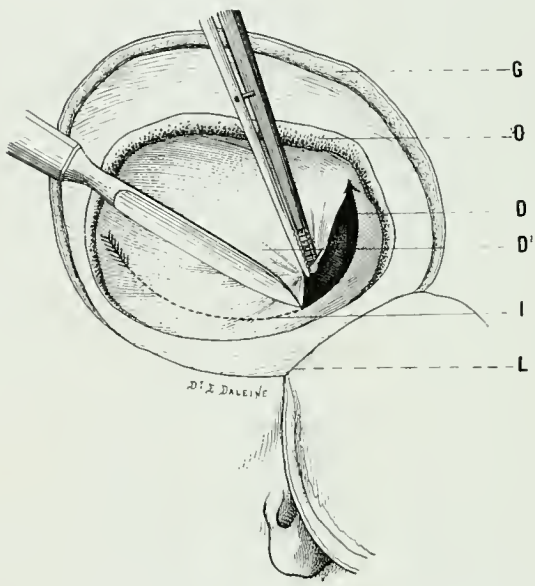


Fig. 73.—Intradural hæmatoma; incision of the dura mater. (G) Skin incision. (O) Margin of the opening in the bone. (D) Incision in the dura-mater, through which the dark-coloured hæmatoma is visible. (D') Upper lip of the incision held by forceps and raised in front of the knife. (I) Line of the semicircular incision. (L) Flap turned down.

Clear out the collection of blood; and remember, firstly, that these subdural hæmatomata are seldom circumscribed, the blood being usually widely diffused all round the principal mass; secondly, that the brain is very often injured, and consequently all manipulations in the depths of the wound must be carried out with the utmost gentleness if serious cortical hæmorrhages are to be avoided.

Again, it may happen that when the dura mater is incised, under a thin layer of blood, the brain itself is found to be tense, prominent, dusky: the *hæmatoma is intracerebral*, and notwithstanding the evident gravity of the lesion, associated as it must be with extensive laceration of the brain substance, it is necessary to incise the cortex, open the collection of blood, evacuate it, and pack the cavity lightly.

[1] Is the following not a very definite experiment?—Comminuted fracture in the right temporal region, symptoms of compression, steadily progressing; noisy stertor. I operated on the patient, exposed a large extradural clot, and removed it with the fingers and the curette; the depressed brain expanded, the stertor disappeared. Some oozing of blood persisted, however, and the dressing was re-applied a little more tightly: the stertor immediately recurred. The bandage was loosened; it ceased again. The practical lesson is easily drawn.

(*B*). **LOCALIZED COMPRESSIONS.**—The symptoms of compression do not appear in the form so characteristic of the large extra- or intradural hæmatoma due to rupture of the middle meningeal artery; they are more localized (monoplegias, aphasia), though quite as definite, and if they less frequently necessitate urgent intervention, their study is none the less important.

If any "local sign" exists—a depression or a fissure—it will indicate naturally the point for intervention; if no such indication on the surface of the skull is found, or if the "local sign" does not correspond to the seat of the deep lesion as indicated by the nature and localization of the peripheral symptoms, the operation must be guided by the teachings of **craniocerebral topography.**

Fig. 74.—Seeking the inion (the external occipital protuberance). The right thumb follows the superior curved line of the occipital bone outwards from the posterior border of the mastoid process, which is marked by the left thumb.

Fig. 75.—The sagittal line. A tape measure marks the line; the right index finger marks the posterior extremity at the inion; the left thumb marks the anterior extremity in the nasofrontal groove. The left index is applied to the glabella.

A knowledge of certain simple and definite facts is indispensable, and a careful study of the cranium, bony landmarks, and principal lines is a useful preparation. It is with this object that we reproduce and explain the accompanying photographs:—

Seek then and determine carefully the following guiding lines:—

1. **The Sagittal Line,** the median antero-posterior line of the cranium.

Carry your finger along the bridge of the nose, from below upwards: at its root you find a definite groove, surmounted by a median prominence (*the glabella*). In this groove, frontonasal or subglabellar, fix the anterior end of your tape-measure.

On the posterior aspect of the skull, seek from below upwards the external occipital protuberance, the inion (*Fig.* 74), mark it, and apply to it the other end of the tape, which, when stretched between these two points over the vertex, indicates the sagittal line (*Fig.* 75). On this line you will now mark the superior Rolandic point and the bregma.

2. **The Superior Rolandic Point,** the superior (sagittal) extremity of the line of Rolando.

(*a*). **Find the Bregma.**—If you have at your disposal a Broca's flexible set-square, place the centre point in the external auditory meatus, bend the horizontal limb around the face, close under the nose, and apply the other over the convex surface of the skull down to the opposite ear: the

Fig. 76.—Seeking the bregma. Broca's flexible set-square; the left hand is applying the horizontal limb immediately under the nose; the right thumb marks the bregma at the posterior border of the vertical limb, at the point where it crosses the sagittal line.

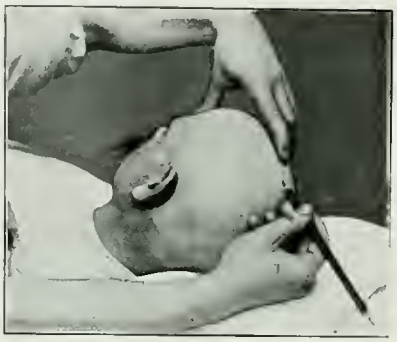


Fig. 77.—Seeking the superior Rolandic point. The tape which has measured the sagittal line is folded in two, and applied doubled along the sagittal line from before backwards, beginning at the frontonasal groove (left thumb); 2 cm. (¾ in.) behind the point where it ends (left index) the pencil marks the superior Rolandic point.

point where it crosses the sagittal line gives you the bregma. Always mark the point at the posterior border of the instrument (*Fig.* 76).

In the sitting position with the head erect, this little proceeding is

Fig. 78.—Seeking the superior Rolandic point. Beginning at the frontonasal groove, measure 18½ cm. (7¼ in.) along the sagittal line.

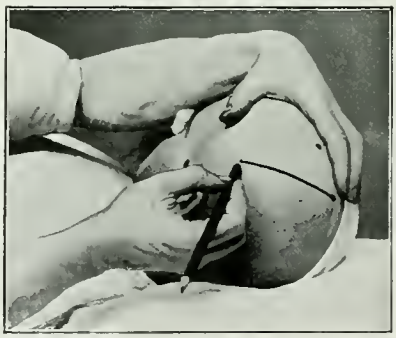


Fig. 79.—Direction of the line of Rolando. On the sagittal line are marked, in front the bregma, behind the superior Rolandic point. From the superior Rolandic point a line is drawn towards the middle of the zygomatic arch: it is the line of Rolando. The pencil is stopped approximately at the inferior Rolandic point.

easy; it is necessary, however, to accustom yourself to do it with the patient recumbent. If you have not a square, take a sheet of cardboard. Hollow it out sufficiently on one side to allow of it being placed vertically,

saddle-wise, on the head, and to correspond exactly on either side with the external auditory meatus. A straight rod of any kind is fixed perpendicularly to the plane of the sheet of cardboard at the level of the eyes.

Fig. 80.—Direction and length of the line of Rolando. The right thumb fixes the tape at the superior Rolandic point; the tape is directed towards the middle of the zygomatic arch, and the left thumb marks at 9 cm. (3½ in.) the inferior Rolandic point.

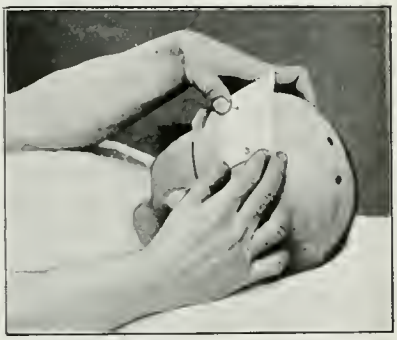


Fig. 81. Inferior Rolandic point. Visiting-card method. On the sagittal line are marked the bregma and the superior Rolandic point.

It only then remains to arrange the rod parallel to the line of vision in the horizontal plane, and the point where the cardboard arch crosses the sagittal line is the bregma (Lucas-Championnière).

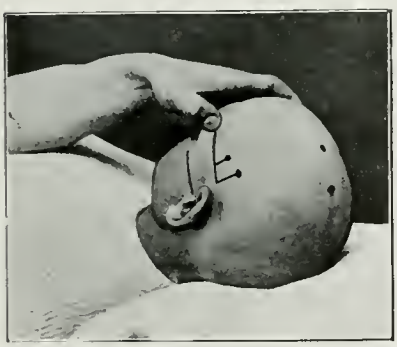


Fig. 82.—The inferior Rolandic point and Broca's convolution. A horizontal line is drawn from before backwards from the external angular process, which is marked by the left thumb; on this line 7 cm. (2¾ in.) behind the process, a perpendicular of 3 cm. (1¼ in.): the inferior Rolandic point; 5 cm. (2 in.) behind and 2 cms. (¾ in.) above: Broca's convolution.

Fig. 83.—Inferior Rolandic point 7 cm. (2¾ in.) above the inferior horizontal line, on a pre-auricular perpendicular. The thumb and left middle finger mark the limits of the line of Rolando, which is prolonged towards the middle of the zygomatic arch.

Another method: draw a line from the inferior border of the orbit, along the zygoma, to the external auditory meatus, a line practically horizontal on all heads. It is the inferior horizontal line of the cranium.

Apply a tape at right angles to this line from one auditory meatus to the other. The tape indicates the position of the bregma at the point where it crosses the sagittal line.

You have the bregma: behind this point, on the sagittal line, measure off $5\frac{1}{2}$ cm. ($2\frac{1}{4}$ in.) in the male, 5 cm. (2 in.) in the female, and you will have the superior Rolandic point (Broca, Lucas-Championnière). Or:—

(*b*) Measure the sagittal line, double the measured portion of your tape, fix one of the ends in the frontonasal groove, apply the doubled tape along the sagittal line, from before backwards: beyond the point where it ends, measure 2 cm. ($\frac{3}{4}$ in.): you are on the superior Rolandic point (*Fig.* 77).

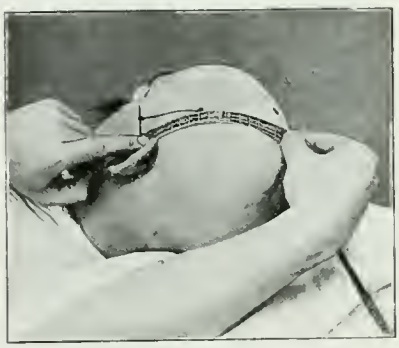


Fig. 84.—Inferior Rolandic point, at a finger's breadth below the middle of the auriculo-sagittal line (indicated by the tape measure.)

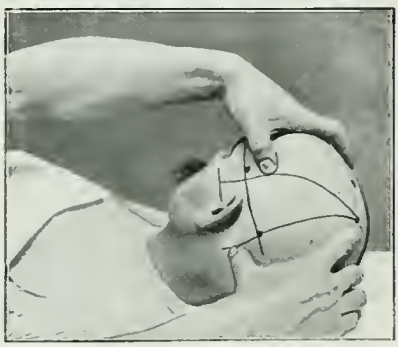


Fig. 85.—Observe on this figure the inferior horizontal line along the zygomatic arch; the superior horizontal line springing from the upper border of the orbit and parallel to the preceding; the retromastoid perpendicular, extending upwards to the superior Rolandic point (between the right thumb and index). At the junction of the retromastoid perpendicular and the superior horizontal, the position of the posterior branch of the middle meningeal (marked by a dot); on the same superior horizontal, the second dot marks the position of the anterior branch of the middle meningeal. Between the right index and the left thumb, the line of Rolando, which, prolonged, meets the middle of the zygomatic arch.

(*c*) Another check method: From the frontonasal groove measure on the sagittal line $18\frac{1}{2}$ cm. ($7\frac{1}{4}$ in.) (Poirier): this gives the superior Rolandic point (*Fig.* 78).

3. **The Inferior Rolandic Point.—The Line of Rolando.**—

(*a*) You have the superior Rolandic point: from this point carry the tape towards the middle of the zygomatic arch, measure 9 cm. ($3\frac{1}{2}$ in.): you will have the direction and the length of the Rolandic line and its inferior point (*Figs.* 79, 80, and 85).

(*b*) Follow the posterior border of the orbital process of the malar bone from below upwards until you reach the bony prominence which marks the point where the temporal crest begins: this is the external angular process; from it, draw a line parallel to the inferior horizontal, and on this line, from before backwards, measure off 7 cm. ($2\frac{3}{4}$ in.); at this distance, erect a perpendicular 3 cm. ($1\frac{1}{4}$ in.) long: it ends at the inferior Rolandic point (Broca, Lucas-Championnière).

(*c*) The visiting-card method considerably facilitates the investigation.

On one of the long sides of the card mark off 7 cm. ($2\frac{3}{4}$ in.); from the same corner, on the short side 3 cms. ($1\frac{1}{4}$ in.); apply the card as shown in *Fig.* 81, parallel to the inferior horizontal: the inferior Rolandic point corresponds to point 3 on the card. The marks obtained are shown in *Fig.* 82.

(*d*) Check method: on the inferior horizontal, immediately in front of the tragus, erect a perpendicular 7 cm. ($2\frac{3}{4}$ in.) long (Poirier): you are at the inferior Rolandic point (*Fig.* 83).

Prolong this perpendicular to the median line: this gives the auriculo-sagittal line. The inferior Rolandic point is a finger breadth below the middle of this line (*Fig.* 84).

4. **Broca's Convolution.**—By means of the tape or the visiting card, draw, beginning at the external angular process, a horizontal 5 cm. (2 in.) long, and at its posterior extremity a perpendicular 2 cm. ($\frac{3}{4}$ in.): it ends at the foot of Broca's convolution (*Fig.* 86).

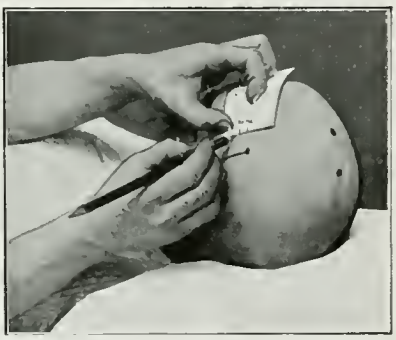


Fig. 86.—Fixing the position of Broca's convolution. Visiting-card method. 5 cm. (2 in.) are marked on the lower margin of the card, 2 cm. ($\frac{3}{4}$ in.) on the vertical border. The inferior border is applied parallel to the zygomatic arch, starting from the external angular process; the pencil is marking the perpendicular 2 cm. ($\frac{3}{4}$ in.). Behind, the inferior Rolandic point is shown at the upper end of a perpendicular measuring 3 cm. ($1\frac{1}{4}$ in.). On the sagittal line are marked the bregma and the superior Rolandic point.

Krönlein's method deserves to be remembered; it requires no figures, and gives results which are sufficiently correct for all practical purposes. Mark (*Fig.* 87) the inferior horizontal line of the cranium (inferior border of the orbit, auditory meatus), and the superior horizontal, parallel to the first and touching the superior border of the orbit; from one to the other, draw three vertical lines, *the anterior* springing from the middle of the zygomatic arch, *the middle one* from the temporomaxillary articulation, *the posterior* from the posterior margin of the mastoid process. Prolong the retromastoid perpendicular up to the sagittal line: you have the **superior Rolandic point**; join that to the point where the anterior perpendicular crosses the superior horizontal: you have **the direction of the line of Rolando**; prolong the middle perpendicular till it meets this oblique line: you have the **inferior Rolandic point.** Lastly, the bisector of the posterior angle bounded by the oblique line and the superior horizontal indicates **the line of Sylvius.**

Once in possession of the Rolandic[1] and Sylvian lines, it is easy to determine the position of the principal cortical centres: those of the lower extremity, the upper extremity, and the face are arranged, from above downwards, along the Rolandic line: the first at the level of the upper

[1] One is always inclined to seek the Rolandic line *too far in front*: it should be remembered that it is always *well behind the fronto-parietal suture.*

third ; the second at, and a little in front of, the middle third ; the centre for the face at the lower third. The speech centre is situated in front of and a little below the inferior Rolandic point.

In practice, and in addition to the preliminary determination of the craniocerebral relationships, it is well to keep in mind some very simple points, which will serve as guides when the skull is exposed (*Fig.* 88) : Broca's convolution corresponds to the antero-inferior angle of the parietal bone ; the fissure of Rolando, which one always inclines to place too far forward, is situated behind the fronto-parietal suture, two finger breadths from the lower end of the suture, three finger breadths higher up ; the anterior branch of the middle meningeal artery ascends on the inner surface of the spheno-parietal suture, crosses the pterion and runs upwards, $\frac{1}{2}$ cm. ($\frac{1}{4}$ in.) behind the lower part of the fronto-parietal suture, 1 cm. ($\frac{2}{3}$ in.) behind the upper part ; the posterior branch of the middle meningeal crosses the squamous suture two finger breadths behind the upper end of the spheno-squamous suture.

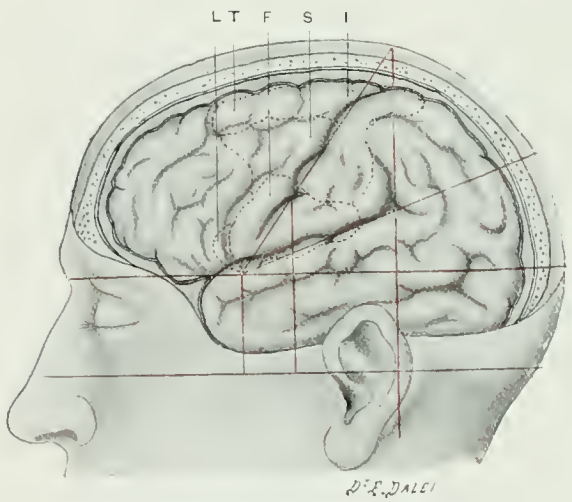


Fig. 87.—Kronlein's Method. (F) Face movements. (I) Movements of the lower limb. (L) Articulate speech. (S) Movements of upper limb. (T) Movements of trunk.

These points are as a general rule amply sufficient for satisfactorily fixing the position of the opening in the skull, which further should always be of good size, and for which the " trap-door " is the method of choice.

Infected Fractures.—Too often fractures of the vault, especially fissured fractures, are at first unrecognized or badly treated : the wound remains dirty, and the surgeon is not called, we presume, until it is already suppurating.

(*a*) Notwithstanding the possible absence of any symptoms, the surgeon's duty is now quite as pressing as when dealing with a recent injury—perhaps more so : it is necessary to enlarge the wound at once ; to cleanse and disinfect it ; to extract loose fragments of bone, making a track, if need be, with the chisel or the gouge-forceps ; to cleanse the subcranial area, and complete the operation by providing free drainage, leaving the skin wound wholly or partly open.

(*b*) At other times, serious symptoms give evidence of the existence of intracranial suppuration — intradural or extradural. The patient,

submitted at first to methods still dignified by the title of expectant treatment, is seized after some days, sometimes rather late, with fever, shivers, intense headache, delirium, convulsions, diffuse sensori-motor symptoms. Again, one may find himself face to face with various **focal phenomena**: Jacksonian epilepsy, localized paralysis, or aphasia, which would justify a suspicion of localized suppuration, or abscess.

In either hypothesis, the seat of fracture must be opened up, enlarging the opening as much as may be necessary: if an extradural collection of pus is found, it must be evacuated, and the cavity cleansed and drained: when the dura mater is intact and apparently normal, nothing more is required, and the prognosis will usually be fairly good.

It is far otherwise, however, **when the dura mater is torn**, the brain injured, and the pus diffused in a deep irregular cavity, surrounded by softened brain substance: cleanse the cavity carefully with little pledgets of sterile gauze mounted in forceps, curette the walls very gently, and provide good drainage: you can do nothing more.

Fig. 88.—Fixing positions on the surface of the cranium, exposed for trephining. The fronto-parietal and squamo-parietal sutures are shown; the dotted line indicates the fissure of Rolando; the two shaded lines, the two branches of the middle meningeal; the shaded area at the level of the antero-inferior angle of the parietal bone marks the position of Broca's convolution.

Again, it may happen that under the dura mater **the brain is found bulging, tense, without pulsation**, and often with the cortical fissures choked up with a glutinous effusion. Do not hesitate to thrust a straight scalpel into the middle of a convolution at the centre of the bulging immobile area: do not be content with a simple puncture, but incise the cortex sufficiently to allow of the abscess being thoroughly emptied and properly drained.

Here we may mention that in all these localized traumatic suppurations, drainage ought to be continued for **a very long time**, the drainage tube being frequently changed and the cleansing repeated; if, feeling satisfied by the remission of symptoms which commonly follows the evacuation of the pus, the operator leaves things alone, or if, in view of the fall in temperature, he hastens to remove the drain, he will expose himself to bitter disappointment, and the retention of pus in tissues so well adapted to serve as culture media will reveal itself at no distant date by the return and aggravation of the symptoms.

There remains another possible complication, most serious of all, characterized only too clearly by wide oscillations of temperature, weakening

pulse, vomiting, convulsions, delirium, and coma: we mean **diffuse meningo-encephalitis.**

If we sometimes cure general peritonitis, or at least some forms of general peritonitis, it must be admitted we never cure diffuse meningo-encephalitis; and all attempts at washing out the subdural space have, up till now, been attended by the most discouraging results.

However, speaking for ourselves, we should not hesitate to employ the method again on the lines followed on two previous occasions: the primary opening was enlarged, another hole bored at some distance, and several pints of warm sterile saline solution were injected slowly under the dura mater. Who will condemn this last resource, which, if adopted at an earlier stage and more boldly carried out, may some day, perhaps, prove to be a life-saving operation?

Fractures of the Base of the Skull.—In fractures of the base, the most common cause of death is meningo-encephalitis, that is to say, **infection** which finds its way into the cranial cavity along the line of fracture, through which a communication may be established with the nose, the pharynx, or the ear. The practical conclusion is easily drawn: it is necessary to cleanse the ear immediately and carefully, to close the external auditory canal with a little plug of aseptic gauze (*see* p. 82), and to spray the nose, mouth, and pharynx frequently with a weak antiseptic solution, or simply with very warm boiled water. We have seen most characteristic fractures of the base cured in this manner, and such cases are by no means rare.

We may add that lumbar puncture, useful from a diagnostic point of view in doubtful cases, may sometimes become a means of treatment for coma, which may be relieved at least temporarily, and for headache, which becomes less severe and may disappear after the withdrawal of some of the cerebrospinal fluid.[1]

Before diffuse meningo-encephalitis we are helpless: therefore, practised early, trephining and drainage of the dura mater constitute, as we have already said, a rational procedure which has succeeded in the hands of P. Poirier.[2]

[1] Extraction of 10 to 20 cc. (2 to 5 dr.), repeated usually several times. (*See* Quénu, "Valeur thérapeutique de la ponction lombaire dans les fractures de la base du crâne." *Bulletin de la Soc. de chir.*, 31 octobre, 1905, p. 883.)

[2] The case was one of fracture of the anterior fossa, at the sixth day, with meningeal complications; on each side of the skull immediately above the ears, a plate of bone 2¼ in. high by 2 in. broad was cut out and the dura mater incised: a considerable quantity of reddish, sticky fluid escaped; the temporal lobe was raised with the fingers, and a further quantity of the same liquid appeared. Two drainage tubes were placed in position on either side, one to a depth of about 5 in., between the base of the brain and the tentorium cerebelli, the other, shorter, directly under the temporal lobe. Recovery. (P. Poirier, "Fracture de l'étage antérieur du crâne, méningite consécutive, trépanation double, guérison." *Bulletin de la Soc. de chir.*, 13 janvier, 1901, p. 17.)

GUNSHOT INJURIES OF THE SKULL.

In civil practice, injuries of the skull caused by the modern long-range rifle or the service revolver are very seldom seen. The injuries produced by these weapons are almost invariably of extreme gravity: possessed of enormous penetrating power, and preserved from any distortion by their hard envelopes, the projectiles usually traverse the cranium from side to side and at the same time exercise an enormous bursting and splintering action: very rarely, spent balls may produce lesions comparable with those we observe in non-military practice.

Here we have to do with soft lead bullets, easily deformed, endowed with a very limited penetrating power, and often fired from very short range. The arms commonly employed are the revolver, the various forms of pistol, and sporting guns charged with bullets, slugs, or shot.

It is desirable to distinguish and study these injuries separately according to the region affected: (1) *Gunshot wounds of the vault of the cranium*; (2) *Of the orbit*; (3) *Of the mouth*; (4) *Of the ear*.

I.—GUNSHOT WOUNDS OF THE VAULT OF THE CRANIUM.

In suicidal attempts, it is most often at the temple, and especially at the right temple, that the shot is fired, or perhaps at the forehead. On the vertex, in the latero-posterior region, or at the occiput, bullet wounds are more rare, and are usually due to accident or to a homicidal attempt.

A young man of twenty-two years discharges a revolver, No. 7 calibre, at his right temple. The report attracts immediate attention: he is found stretched on the floor, but perfectly conscious. He raises himself unaided; he is in a state of violent excitement, but presents no localizing symptoms. Three finger-breadths behind the external angular process, a rounded, black perforation is discovered, from which a little blood runs.

Examine the weapon, ascertain the nature of the projectile and of the charge, the position of the injured man, the direction of the revolver barrel at the time the shot was fired: do not, however, attach any very great importance to the information given with regard to the last points. Notice if there is any escape of blood from the ears or nose, enquire if the patient has spat up any blood: make sure that there is no visual trouble.

Lastly, examine the surface of the cranium with the eye and the finger; see if there is not another wound or perhaps some swelling or projecting point. Open the mouth and examine the back of the throat and the palate. Do not forget that blank charges, when fired close to the skull, may cause contused wounds, the appearance of which is very deceiving.

Until this preliminary examination has been carried out, *do not touch the wound*. On no account must a finger be put into it, a probe, a director, or any other instrument introduced. Shave the scalp widely round the blackened wound, over an area 3 or 4 in. in diameter; soap, brush, and wash it with ether and boiled water. Advantage may be taken of the

coma or stupor which sometimes follows the accident to do all this, or, if necessary, a little chloroform may be cautiously given.

The head should now be fixed in good position and the damaged area satisfactorily exposed. Raise and retract the torn edges of the wound; enlarge it, if necessary, with two cross cuts of the scissors, and conscientiously cleanse the whole space with swabs soaked in sterilized water; remove any foreign bodies, hairs, dirt, etc., and scrub the deep surface of the surrounding stripped-up skin. **Then only may you examine the cranium.**

1. **If there is no opening, but a simple depression,** more or less fissured, the ball has not penetrated.

Look for it under the edges of the wound; it may be found sometimes free, sometimes more or less distorted, and adherent to the bone, but apparently capable of being removed without difficulty; then, extract it immediately with a pair of forceps, or, should it hold somewhat more firmly, with the end of an elevator or with a sharp spoon. If it is buried in the bone and only to be extracted by means of the chisel and mallet, it will be wise to defer this by no means indispensable step. Do not prolong the search unduly: radiography will subsequently give information as to the presence and site of the bullet, and it can then be removed if it is causing trouble.

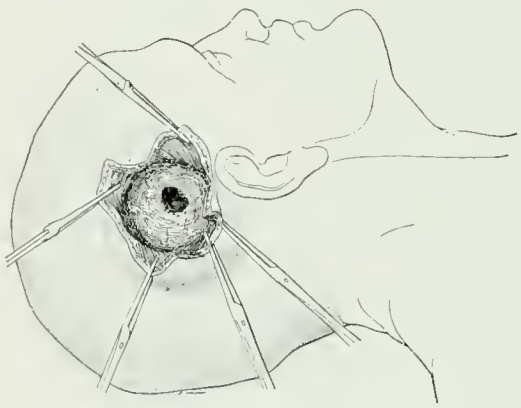


Fig. 89.—Revolver bullet wound in the right temple. The external wound is opened up and the edges are retracted.

Be content with lightly packing a fold of aseptic gauze into the wound, and then apply the dressing.

2. **A round punched-out hole** is more often discovered on the surface of the skull (*Fig.* 89); sometimes it is partly plugged by the bullet, but it is usually open, and in the depths you see only bony débris and clots.

The size of the opening has a certain relationship to the penetrative force of the ball: if it is large, the shot has been fired from close at hand, and it may usually be inferred that the ball is deep.

Gently extract the bullet with the forceps, if it presents itself, and one by one the loose splinters of bone; then cleanse the opening with a piece of gauze: if there are any fissures radiating from it, examine it to see whether they are large, and if they run towards the base;[1] examine the dura-mater at the bottom of the wound: if it is intact, if it still pulsates, the

[1] Indirect fractures of the base constitute a comparatively rare but very serious complication of gunshot wounds of the vault of the skull, and when present render the prognosis very much more grave.

prognosis remains fairly good,[1] notwithstanding the perforation of the bone. If the bullet is not visible, one may examine with a blunt probe or director the area from which the dura mater is stripped—all round and particularly below the orifice—and determine whether the projectile is not close at hand and to be easily extracted by enlarging the cranial opening in the necessary direction with the gouge-forceps. At this stage, if the ball is not speedily found, it is not advisable to persist with a search which may later on be greatly simplified by radiography.

Perhaps the dura mater is found with an **irregular perforation from which broken-down brain tissue is escaping.**

The bullet is in the brain. Where? We do not know, and have no means of knowing. **Any primary search for a projectile buried in the brain is both dangerous and uncertain.** Indeed, the direction of the intracerebral track is always doubtful and indeterminable; then, even if the projectile still occupies some point in this track, we cannot tell at what depth it lies; it may be flattened out, caught in the falx cerebri, or lying on the opposite side at the deep surface of the skull: or again, it is often reflected and takes a retrograde course, inaccessible to any exploration (see *Fig.* 90).

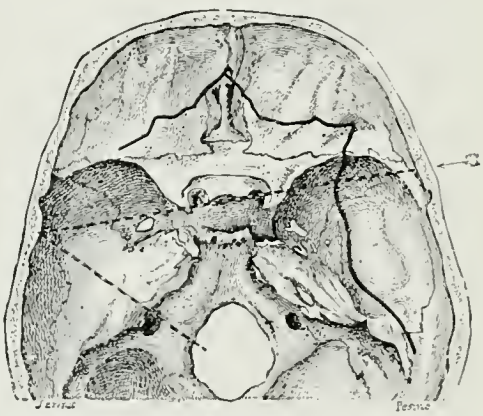


Fig. 90.—Indirect fracture of the base of the skull caused by gunshot. The dotted line indicates the track of the projectile within the cranium, before and after its reflexion from the wall opposite the wound of entry.

Again, no matter what exploring instrument is used, even should it be a sterilized soft rubber catheter, false passages are almost inevitable; even when the opening in the brain is apparently quite definite for an inch or so, beyond that depth we cannot know what we are doing, a fact of which we have convinced ourselves in three different cases. It is hardly necessary to add that the meeting with a hard body is no certain indication that we are on the ball: a scale of bone will give exactly the same sensation. Certain cases undoubtedly prove[2] that bullets buried in the brain

[1] Do not, however, conclude too hastily that the dura mater and brain are uninjured; sometimes the bullet slips between the endocranium and the membrane, and perforates the latter at some distance from the point at which it entered the skull.

[2] For instance, a case of Morestin's, which was a complete success. A man, aged 38, had some hours previously fired three shots from a revolver at his right temple; there were three wounds; no cerebral symptoms. A flap, convex upwards, was cut and turned down. One bullet was found under the scalp, and another embedded in the bone: the cranial perforation was enlarged, to extract the splinters, and the dura mater was seen, dark and distended with blood. It was incised, clots and brain tissue escaped; at the bottom of the cavity, towards the base of the skull, the finger felt in the temporo-sphenoidal lobe a bullet, which was easily extracted with forceps. Packing with sterile gauze. Recovery. (*Soc. de chir.*, 7 nov., 1900.)

may be found and extracted, but they are rare; and still more uncommon are those in which the extraction has been followed by the patient's recovery. Therefore, go no further; make no exploration, either with probe, sound, or finger; make no attempt to "disinfect" the intracerebral track, an attempt almost always useless and always dangerous.

Let the proceeding be restricted to clearing the bony opening of foreign bodies, splinters of bone, clots, hairs, etc.; introduce the end of a strip of sterile gauze down to the entrance of the intracerebral track, and pack the rest of the strip lightly in the mouth of the wound.

Excluding the cases—quite exceptional—where the projectile presents itself at once, the question of extraction ought only to be considered at a later date, according to the symptoms and the radiographic findings.

There is only one indication for doing more—hæmorrhage, whether external and immediate, or making itself evident in the first days of the case by symptoms of cerebral compression.

If the escape of blood from the cranial orifice is very abundant, persistent, and uncontrolled by the first packing, it is very probable that a vessel of some size—middle meningeal—or a sinus, is affected: then no time should be lost in opening up the wound and enlarging the cranial opening with the gouge-forceps; turn out the clots, enlarge the perforation in the dura mater if necessary, and look for the bleeding point; ligature, plugging with catgut, or gauze packing will be employed as the conditions demand.

In another case, the primary hæmorrhage has been moderate, as is usual; but in the first twenty-four, thirty-six, or forty-eight hours compression symptoms appear and steadily progress: the stupor deepens, stertor comes on, and the pulse weakens. Here, again, intervention is necessary to remove the clots and relieve the pressure.

II.—GUNSHOT WOUNDS OF THE ORBIT.

Practically, it is necessary to distinguish between shots fired directly into the eye, or which strike the globe obliquely from one or other side, and those which involve only the retrobulbar part of the orbit.

The bullets which enter by the cheek, the root of the nose, the temple, or the forehead, may traverse or remain in the orbit, divide or compress the optic nerve or the vessels, and produce most serious and sometimes irremediable ocular trouble. The immediate indications differ according to the existence or otherwise of serious lesions of the globe.

1. **The eyeball is hopelessly damaged.**—While cleaning a revolver, which he thought was unloaded, one of our patients discharged the weapon, and received a bullet at the root of the nose. Loss of consciousness, and profuse bleeding from the wound, resulted. Two hours later we find the wound of entry, black and lacerated, a finger's breadth to the inner side of the internal canthus; the track is oblique, upwards and outwards. Enormous swelling of the lids, which can scarcely be opened. Under chloroform the globe is found relaxed, the cornea ruptured, the vitreous

humour almost completely gone : the eye, having been traversed from side to side by the bullet, is destroyed.

In such a case, only **immediate enucleation**, followed usually by emptying the orbit, allows the two fundamental indications of disinfection and drainage being fulfilled. This prevents grave complications, orbital suppuration, sympathetic ophthalmia, or meningo-encephalitis, for the onset of which it would be foolish to wait.

If the palpebral swelling is very great, the necessary room can be obtained by incising the external canthus in an outward direction for a distance of an inch. The two lids being then widely retracted, the conjunctiva is divided circumferentially at a distance of $\frac{1}{4}$ in. from the corneal margin, and the eyeball quickly isolated with curved scissors or a director. As this is generally only the first stage of emptying the orbit, it is unnecessary to take the usual precautions for preserving the capsule of Tenon, which is itself often lacerated. The best plan is to seize the globe, or what remains of it, with a pair of toothed forceps, and tilting it successively downwards, upwards, and to either side, to cut the attachments of the four recti and the two oblique muscles with the curved scissors, and finally, as far back as possible, the optic nerve.

Usually the collection of blood which occupies the bottom of the orbit is opened at this stage : with the dissecting forceps and the curved scissors excise rapidly the rest of the orbital contents—the remains of the capsule, the fat, and the muscles. The bleeding is then very free : pack the cavity and wait a little : it is readily checked by forceps pressure and packing.

Now look for the aperture of exit, or rather the aperture whereby the ball has entered the cranial cavity : it may be that an escape of brain matter during the enucleation of the eyeball or the clearing of the orbit has already indicated the gravity of the deeper lesions.

It is most often through the roof of the orbit, or its inner wall, that the bullet has passed : the orifice is enlarged, splinters are removed, the subdural or intracerebral focus is cleansed (*see* p. 74) as before, without making the removal of the projectile the principal object of the operation, which is terminated by placing a drainage tube in good position and packing the orbit.[1]

[1] The following case reported by Bayer may serve as an example : Man aged 29 years, revolver bullet wound of the right orbit. The two lids are swollen by an effusion of blood which extends into the orbit and over the fronto-parietal region, so that they can scarcely be separated. The wound of entry, about $\frac{1}{4}$ in. in diameter, irregular, lacerated, and blackened, is situated at the root of the nose, about half an inch from the inner canthus ; it leads into a track running obliquely from below upwards and from within outwards. Under chloroform it is found that the cornea is ruptured, the globe perforated, and the vitreous almost completely lost. Enucleation of the eyeball is immediately performed, a stump of the sclerotic, the size of a threepenny piece, being left around the optic nerve. Some brain matter is seen to escape from the roof of the orbit. The orbital cavity is therefore cleared of its contents : the hæmorrhage from the ophthalmic artery stops under pressure, but blood continues to flow in abundance from an opening with irregular borders situated an inch behind the upper margin of the orbit, a little outside its middle line. The orifice is enlarged with the chisel and mallet, some splinters are extracted without difficulty and then an intracerebral track is discovered, in which a very cautious exploration with a director fails to detect the bullet. Half a teaspoonful of brain tissue escapes ; after careful disinfection with sublimate solution, the cavity is packed with iodoform gauze. The incision at the outer canthus—about an inch long—is sutured : the margin of the wound of entry is excised. After some temporary hemiplegic symptoms, the patient was able to leave Czerny's clinique five weeks later. (Bayer, "Zur primären Trepanation bei Schussverletzungen des Schädels," *Beitr. zur klin. Chir.*, 1897, Bd. xvii., 3, p. 743, obs. 5.)

2. **The eyeball is not seriously damaged.**—We wish to speak of the cases in which the bullets traverse the posterior part of the orbit, or even the retro-orbital region, producing directly or indirectly **lesions of the optic nerve** which are rendered evident by the loss, or a considerable diminution, of the power of vision.

A young man fires a revolver shot at his left temple: comparatively short loss of consciousness, no hæmorrhage from the wound, no cerebral symptoms, but immediate and *absolute loss of vision with the left eye and a notable diminution with the right.* On the left temple, a finger-breadth behind the external angular process, and two finger-breadths above the zygoma, a blackened hole, as large as a shilling, is found. The tension of the left eyeball is normal, the pupil is dilated and immobile, the cornea insensible, and there is no exophthalmos.

The abolition of vision may be due to: *section or crushing of the optic nerve by the bullet: its section or compression by a fragment of bone; its compression by an intra-orbital hæmatoma.* Whatever be the cause, it is of the utmost importance to act immediately, to relieve the nerve from pressure, if it is intact, and to disinfect the bullet track, which may quite possibly end in the brain.

A crucial incision is made at the wound of entry, followed by division of the temporal muscle down to the bone, the four cutaneo-musculo-periosteal flaps being raised with the elevator. A round, somewhat splintered orifice is found on the lower part of the great wing of the sphenoid: this is enlarged with the gouge-forceps, and some subcranial splinters and clots are removed; the dura mater appears to be intact and is pulsating: no track appears to lead into the orbit; below, the director, carefully handled, slips down towards the base of the skull. Light packing; no suture of the wound.

No cerebral symptoms develop, and the patient recovers: but vision with the left eye does not return, and in the right is only very slowly restored. A radiographic plate showed that the ball had lodged in the vicinity of the optic chiasma.

In this case the projectile was, because of its situation, inaccessible. More frequently, when the orifice of entry is enlarged it will be found to lead into the orbit: with great care the blood will be evacuated, the clots, bony débris, and fragments of the bullet will be removed bit by bit: if the eye can be saved, it will only be by this method; if it is already lost, the disinfection and drainage of the orbital focus will prevent, as far as is possible, the development of complications.

III.—GUNSHOT WOUNDS OF THE MOUTH.

When the bullet has penetrated into the cranial cavity, these injuries are peculiarly serious, because of the great difficulty in dealing efficiently with them. Indeed, any direct intervention is usually impossible, disinfection of the naso-bucco-pharyngeal space is extremely difficult and always imperfect, whatever one may do, and the ultimate result depends to a very great extent on chance.

Inflicted with the service revolver, a bullet wound in the mouth produces terrible lesions: the bursting action of the bullet shatters the maxillary bones, the roof of the mouth, and the base of the skull, and immediate death is the usual consequence.

With "civil" weapons, however, this sudden catastrophe is not so common. The patient has generally lost a considerable quantity of blood from the nose and the mouth; sometimes—and it is well to enquire—bony débris or brain matter has been expelled from the nose or the mouth with the blood. On examining the mouth and pharynx, the tongue is found swollen, the roof of the mouth or the soft palate perforated, split, or fissured; the mucous membrane is usually covered with black spots and swollen around the orifice of entry, which is often seen and recognized with difficulty.

If nothing is seen, the finger introduced into the mouth explores the surface of the palate, its attachments, and the posterior wall of the pharynx. The bullet may perhaps be hidden at some point of the nasopharynx, and in the absence of definite symptoms, endocranial penetration must not be too hastily diagnosed. In one case which we witnessed long ago, an eminent surgeon had affirmed the existence of a cranial lesion, and had even determined the situation of the bullet in the brain, simply from the patient's appearance and his position at the time of the injury: a direct examination showed that the ball was lodged in the posterior wall of the pharynx.

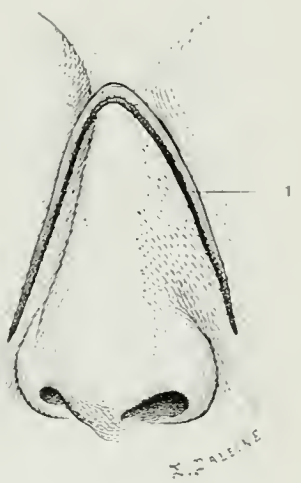


Fig. 91.—Temporary resection of the nose by Ollier's method. (1) Line of incision.

However this may be, we must always act from the outset **as if penetration had been demonstrated.**

The mouth, the pharynx, and the nasal fossæ should be sprayed every three hours with a warm antiseptic solution (chloral, weak hydrogen peroxide, etc).

If the bleeding should be very profuse and persistent, and there is ground for suspecting that a large vessel is wounded, it is possible, by Ollier's method of temporary resection of the nose, to get fairly good access to the upper parts of the nasal passages and the nasopharynx, and to pack them with success, as has been done by Schwartz.[1]

[1] The case was that of a patient who had received two revolver bullets (calibre 7) in the right temporal region. At the end of six months he reappeared, anæmic from repeated attacks of epistaxis. A fresh, formidable hæmorrhage was checked by packing the nasal fossæ. It was thought that there was necrosis of some part of the roof of the nose, with secondary ulceration into the internal maxillary or one of its branches. Ligature of both external carotids: horseshoe incision round the upper part of the nose: division of the bones with chisel and mallet in line with the skin incision: vertical section of the septum and the lateral cartilages; the nose turned down. The index finger, carried into the right nasal fossa, entered a cavity, placed very far back, containing clotted blood: this cavity was at once packed with a strip of iodoform gauze, the end of which was brought out at the nostril: on the other side, a similar procedure. Packing was removed at the end of a fortnight. Recovery. (*Archives de laryngologie*, 1894, p. 229).

Make a transverse incision, down to the bone, across the root of the nose, and two others descending on either side as far as the corresponding ala (*Fig.* 91); with the chisel and mallet detach the nasal bones and divide the nasal processes of the superior maxillæ vertically: the nose may then be turned down (*Fig.* 92), and it becomes possible to pack the upper part of the pharynx, the sphenoidal sinuses, and the roof of the nasal fossæ. For this purpose, long strips of gauze are used, the lower ends of which are brought out at the nostrils. The nose is then replaced and fixed in position by careful suture of the soft parts.

This method may also be of great value after bullet wounds penetrating the fronto-ethmoidal region, for exposing, clearing, and packing the damaged area.

Lastly, never forget to look for a wound of exit or any local sign which may, in certain exceptional cases, indicate the presence of the ball at some point of the cranial surface.

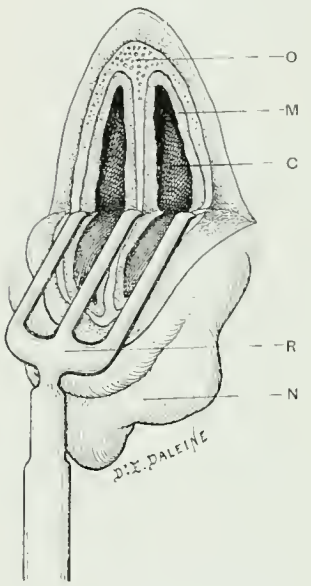


Fig. 92.—The external nose turned down. (O) Nasal bones. (M) Mucous lining. (C) Nasal cavity. (R) Large retractor. (N) Nose turned down.

Case 4.—A non-commissioned officer fired a service revolver into his mouth: profuse hæmorrhage followed: a median perforation of the roof of the mouth was found, and on the vertex of the skull, a little in front of the bi-auricular line, ½-in. to the right of the sagittal line, a little wound less than ½-in. long. The skin alone was involved, the aponeurosis intact; underneath, a comminuted fracture of the vault was felt: crucial incision, extraction of the fragments, enlargement of the orifice: a hard body was felt in the substance of the brain; this was removed and proved to be the bullet, distorted, and weighing nearly half an ounce. The perforation of the palate and the fracture of the vault both healed, and the patient recovered.[1]

Gunshot wounds of the face vary in gravity according to the direction of the bullet and its penetrative force: it may happen that the ball is arrested in the soft parts of the cheek, or is flattened out on the front of one of the maxillary bones, or again, it may be buried in the depths of the parotid or pterygoid regions; more often it penetrates into a neighbouring cavity, producing some one or other of the varied lesions which we have just discussed. A common accident is a fracture of one of the maxillary bones, upper or lower—a partial fracture possibly, limited to the vicinity of the track of the ball.

Lastly, the bullet may lodge in one of the sinuses, particularly in the antrum of Highmore: in one of our patients, the wound of entrance—of a revolver bullet—was on the right side, at the upper border of the

[1] Dupont. "Fracture de la base et de la voûte du crâne par coup de feu; recherche du projectile dans le cerveau; guérison." (*Acad. de méd. de Belgique*, 1896, p. 878.)

malar bone : the track was directed obliquely downwards and forwards ; the lower lid and the cheek were greatly swollen : no wound of exit could be found in the mouth. A radiograph (*Fig.* 93) showed that the ball was in the antrum ; it was inaccessible by the track, even when enlarged ; we therefore opened the sinus through the canine fossa and extracted it easily. Recovery was rapid.

Fig. 93.—Revolver bullet in the right antrum of Highmore.

IV.—GUNSHOT WOUNDS OF THE EAR.

Here again we have nearly always to do with the results of suicidal attempts by means of " civil " firearms : the lesions produced by military weapons are usually hopeless from the first.

The muzzle is sometimes applied directly to the entrance of the auditory canal : at other times the shot is fired from a distance of some inches, usually in the right ear and slightly from before backwards ; the wound of entry may be at the outer part of the canal, in the concha, or in the mastoid region, and from it the track extends for a varying distance in the direction of the deep part of the canal or the middle ear.

The following is the usual history of these cases : the wounded man has fired a revolver shot into the right ear ; he has fallen unconscious or simply stunned, and has lost a considerable quantity of blood. When the surgeon arrives, a thread of blood still runs from the ear, or perhaps the canal is plugged with a clot.

Look for the seat of the wound of entry, and observe if there is any facial paralysis.

If there is no facial paralysis, and the patient is conscious and does not complain of vertigo, buzzing in the ear, or nausea, if the pulse is regular and of normal frequency, there will be good reason for supposing that the projectile has not penetrated far into the ear, and that it will be perhaps readily accessible.

Limiting the treatment to the application of a superficial dressing under the pretext of " not disturbing the clot and respecting hæmostasis " is a fairly common practice, which is, however, irrational and dangerous.

These gunshot wounds of the ear are extremely liable to infection : to abstain, therefore, from any immediate action is to leave the field free to the infective agents ; further, it is to put off until later, possibly under much less favourable conditions, the extraction of the bullet, sometimes a very easy matter at this stage ; in one case known to us, the clot was left undisturbed for three days, and then it was discovered that behind it two balls lay free in the external auditory canal : the point-blank shot had not even affected the tympanic membrane.

Therefore, always proceed to immediate intervention as follows, without forgetting that the reason for acting is not the extraction of the ball—no doubt very desirable—but rather the cleansing of the damaged area and its protection against infection.

Begin by " preparing " the surrounding area, the pinna and its folds, and the auditory canal : irrigation with very warm boiled water, under low pressure, directed well to the bottom of the auditory canal, gives the best results ; it also tends to check any bleeding ; in these cases, however, the primary hæmorrhage is seldom alarming, and yields without trouble.

After this, gently palpate around the ear, the mastoid, and the region of the tragus ; if the wound of entry is outside the auditory canal, explore it with a probe : dry out the canal with little pieces of gauze, remove any clots which may still remain, and examine it closely, placing the ear in a good light or, better, illuminating it with a forehead mirror. In this way one may be able to discover the bullet at once, lying quite superficially.

If not, then make an otoscopic examination ; introduce the otoscope slowly, cleansing—with tiny swabs—and inspecting the walls bit by bit as the instrument passes in. Investigate every black spot. Is it a clot ? A fragment of tissue blackened by the ball ? The ball itself, or one of its fragments ? Touching it with a bent probe will give the desired information. If the tympanic membrane is torn, make a similar examination of the cavity of the middle ear.

1. **The bullet is superficial, visible, immediately accessible.**—The ball may be embedded in one of the walls of the canal, quite visible, or it may be found towards the bottom near the tympanic membrane. It can then be extracted with a small pair of bullet forceps or a pair of Kocher's forceps ; if more firmly fixed, it may often be scraped out by means of a sharp spoon passed behind it and insinuated underneath.

At the bottom of the canal the discovery and extraction of the ball are commonly more difficult. Make certain, by means of the probe or director, that the little blackish, often shapeless mass to be seen below and in front of the membrane is indeed the bullet; if need be, scratch the surface with a sharp spoon and observe if a shining spot is produced. If so, it is certainly the bullet. In seeking to extract it, be careful lest it be pushed into the middle ear or the membrane be torn with the end of the forceps; here again, a little sharp spoon, well handled, is most useful. If the projectile is firmly embedded and cannot be turned out in one piece, it may be possible to break it up with the spoon and then remove the fragments (see *Fig.* 95).

However, if the bullet is fixed and one is cramped for room, it is better not to persist: make an incision behind the ear, turn the pinna forwards (see *Fig.* 96), free the cartilaginous portion of the canal, and

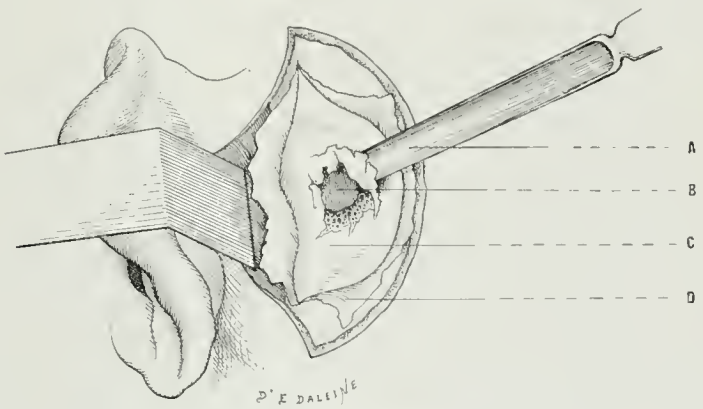


Fig. 94.—Liberating with the gouge a bullet buried in the mastoid process. (A) Gouge removing the margins of the opening of the bone. (B) The embedded bullet. (C) The mastoid process. (D) The periosteum reflected.

split it longitudinally; then with the aid of a good light the extraction may easily be completed.

If the ball has been detected in the middle ear, do not spend time in attempts—always dangerous and uncertain—at extracting it by the auditory canal, but at once turn the ear forward in the manner just mentioned, and by this direct route approach the tympanic cavity.

Remember that its floor lies below the level of the entrance, and that above it extends into the attic; the ball may lie in one or the other recess, and to get at it it may be necessary to cut away the inferior border of the tympanic ring or, above, the wall of the attic (see *Fig.* 97).

In the mastoid process, if the ball has not penetrated deeply, it may be seen and easily felt with a probe; but as forceps operate badly in a channel which is completely choked by the ball, we shall work better, and also more quickly, by enlarging the orifice of entry with a small gouge

(*Fig.* 94), so exposing the margins of the flattened missile and allowing it to be raised with the end of an instrument slipped underneath.

If it is too firmly fixed and too deeply buried for the above method to be applicable, it may, following Berger's example, be broken up with a sharp spoon (*Fig.* 95).

2. **Should the ball not have been discovered at the first examination.**—On no account persist in the search at this stage. If nothing has been found in the examination around the external ear, in the canal, or in the tympanic cavity, then go no further; complete the work of cleansing the area, carry the end of a strip of aseptic gauze as far as possible to the bottom of the track, pack the rest of the strip lightly into the channel, and apply an external dressing. This will suffice for the time being.

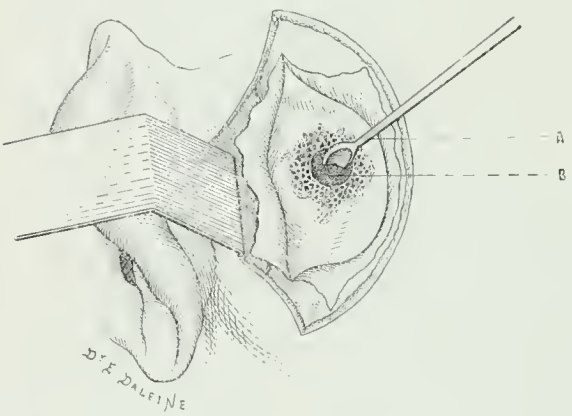


Fig. 95.—Breaking up with the sharp spoon a ball deeply embedded in the mastoid process. (A) Spoon. (B) Bullet.

But the work is not yet complete; the surgeon must never await the onset of serious complications before attempting the extraction of the bullet, but must at once put himself in a position to be able to undertake it as soon as possible; in other words, he must resort to radiography. I may say that we do not always see these cases in the first few hours, and sometimes have to deal with a wound sustained several days previously, already infected, suppurating, and with menacing complications: the need for operation may be urgent; and if a radiograph cannot be quickly obtained, it is necessary to act at once in the manner which we have already outlined; but if the projectile is not readily found, then again it is better to wait, and to base any further action on the results of the radiographic examination.

Where is this bullet which has escaped the primary investigation? Its position may be comparatively superficial, hidden in the wall of the auditory canal; more often it is deep, lying between the mastoid process and the base of the petrous portion of the temporal bone, or lodged at the back of the tympanic cavity in some part of the middle ear, which it has broken up, in contact with, or not far from, the internal carotid. Again, it may have passed on into the base of the skull, or even outside the skull to the back of the pharynx.

Two good radiographs, taken one from the front and one from the side, will tell us: (1) if a ball is actually present, (2), its situation, (3) if it is intact or broken up.

If it is found that the projectile occupies a superficial position, it will be sought by the shortest route, usually the "track," which will be followed and enlarged as may be necessary.

If it is deep, intra-petrous, it must be followed by the retro-auricular route: the external ear is turned forward in the manner already described, the mastoid trephined in its antero-superior quadrant, the antrum is opened: with Stacke's guide passed into the aditus and protecting the facial nerve (see *Plate II*), the outer wall of the passage is cut away; thus a free communication is made between the mastoid antrum and the cavity of the middle ear (*Fig.* 96); then with a narrow chisel and the mallet the wall of the attic is removed (*Fig.* 97), and access to the internal ear is obtained.

The cavity must be well illuminated, but even then the bullet may not be seen at once: it may be embedded in the bone, accessible only by a small part of its surface, broken up, of a yellowish colour if copper cased, and then not to be easily distinguished from the neighbouring bony tissue. Fissures in the bone which bleed, splinters more or less detached, which are freed and removed, sometimes show the road, and permit the exposure of the projectile; at this depth it is necessary to work very cautiously with the probe or sound; it is in such conditions that Trouvé's electric bullet detector finds its special use.[1]

Fig. 96.—Retro-auricular incision, auricle displaced forwards, trepanation, in the search for a projectile.

We may add that even though the electric detector should reveal the presence of metal at the bottom of the track, the information is by no means always complete. Is it the bullet, or is it merely a fragment? Usually we cannot tell.

Whether it is seen, or felt, or detected by electricity, the extraction

[1] This instrument may to a certain extent be improvised, with an ordinary faradic machine, by using the trembler as the indicator, after Leriche's ingenious method. One of the wires connecting the battery with the machine is replaced by a very long one: this is cut in the middle, and an improvised detector fitted to it in the following fashion: one of the ends of the wire is rolled around a little metal cannula about $\frac{1}{2}$ in. diameter, the other end is attached to a fine steel needle enclosed in a piece of fine rubber tubing; the insulated needle is then introduced into the cannula. If the extremities of the needle and the cannula, arranged in this manner, encounter a metallic body, a circuit is established and the trembler vibrates. Of course, cannula, needle, and rubber tubing must be boiled before being used. (Leriche, "Trépanation du rocher pour balle de revolver." *Comptes rendu du Congrès de chirurgie*, 1894, p. 321.)

of the ball is often a very difficult matter; any violent traction must be avoided, and care must be exercised to liberate as far as possible the flattened and irregular margin (often much distorted and locked into the surrounding bone), so that it may be possible to get a good hold of the ball with forceps, or elevator, or sharp spoon.[1]

The great danger of these extractions lies in the possibility of wounding a large vessel during the course of the manipulations: the best means of guarding against it is by providing free access to the ball. Terrier[2] has opened the lateral sinus: gauze packing controlled the bleeding. Reverdin opened the internal carotid artery, but it was while attempting to remove the bullet with an extractor by way of the auditory canal: a jet of blood burst forth and flooded the patient; a finger introduced into the ear lessened the hæmorrhage, and the common carotid was at once ligatured.

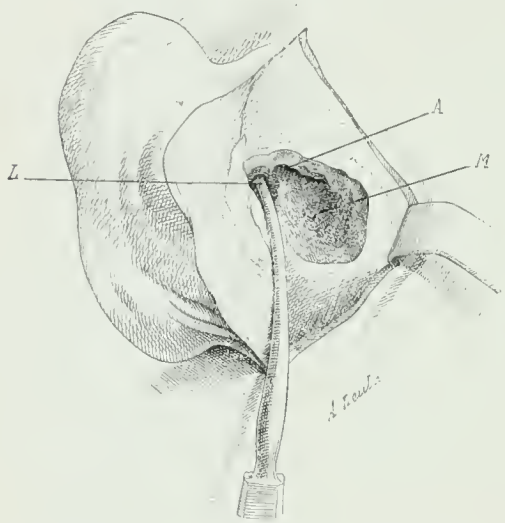


Fig. 97. Trephining the mastoid in the search for a projectile. Stacke's guide is introduced from below upwards into the upper part of the tympanic cavity and applied to the inner surface of the wall of the attic, which is about to be cut away with the chisel. (A) Aditus. (L) Stacke's guide. (M) Opening in mastoid.

When the ball and any loose splinters have been extracted, the cavity is packed, and the ends of the strips of gauze are brought out through the auditory canal; the ear is sutured back in place, the after-treatment and dressings being carried out by the natural passage (see FOREIGN BODIES IN THE EAR, and MASTOID EXPLORATION).

The dangers associated with the early extraction of projectiles are, however, much less than those which result later from deep-seated suppuration in the ear and the possible secondary ulceration of large vessels.

The secondary hæmorrhages, recurrent, sometimes very profuse, constitute most urgent, often vital, indications for operative measures.

After an injury the bleeding has been profuse, but has yielded to packing; next day, or perhaps several days later, hæmorrhage reappears: it is arterial blood, which rapidly soaks through the dressings and runs in a stream down the neck.

Withdrawing the gauze and firmly repacking sometimes succeeds, but

[1] Behind the bullet, the cranial wall is sometimes the seat of a comminuted fracture, as in the case reported by Leriche, who, after the ball had been removed, felt a splinter of bone projecting towards the cranial cavity: this was also removed, and its extraction was immediately followed by the escape of some broken-down brain matter. The patient recovered.

[2] TERRIER. *Bull. de la Soc. de chir.* 1889, p. 62.

is at the best a make-shift, uncertain and dangerous : the bleeding is almost certain to recur, and from this moment everything must be held in readiness for immediate action. It is necessary further to make sure that the patient is not swallowing the blood, which may be escaping into the pharynx by way of the Eustachian tube, even though nothing appears externally. If the hæmorrhage begins afresh the common carotid must be tied at once (see p. 152).

3. **Intracranial Penetration.**—The shot has been fired close to the head, with a full charge and a powerful weapon. There has been no return of consciousness, and the patient is comatose. In addition to paralysis of the facial on the injured side—scarcely ever lacking in serious injuries of the ear—other symptoms of paralysis or contracture may appear. There are vomiting, pupillary inequality, and a feeble pulse. From the bullet track, which at first had bled profusely, issues a copious and persistent discharge of clear serous fluid, mixed sometimes with brain matter.

What is to be done ? Apply an external dressing and let the patient take his chance ? No, for a double reason : (1) It may be that, spite of all appearances, the ball has not penetrated, but has produced, below and in contact with it, a depression, a comminuted fracture, open, infected, or in imminent danger of infection, and which will become the starting-point for a meningo-encephalitis ; (2) If the ball is within the cranium, by enlarging, disinfecting and draining the track we shall do all that is possible to prevent subsequent septic troubles.

Therefore—leaving aside the desperate cases where the patient is evidently dying—the probability or certainty of intracranial penetration commands immediate intervention along the lines already indicated, usually by the retro-auricular route. After the tympanic cavity is freely exposed, if the opening whereby the ball has entered the cranial cavity is discovered on the roof, the anterior wall, or at any other point, the treatment will be conducted as we advised when speaking of gunshot wounds of the vault : the opening will be enlarged by detaching the loose splinters, the bullet will be looked for in or near the opening in the bone if the dura-mater is intact : if the membrane is torn and the brain injured, any intracerebral search will be avoided and the operation ended by providing for drainage and packing the wound. Later, if the patient survives, the extraction of the ball may perhaps be undertaken with radioscopy as a guide.

WOUNDS OF THE SCALP, FACE, PALATE, AND TONGUE.

A man is run over by a carriage : he is found covered with blood : the scalp, split all along the vertex, hangs in a flap over the eye and ear : the bone is bare over half the skull, and bleeding continues abundantly. Numerous vessels are spouting, the wound is choked with hair, dust, and débris of all kinds ; soiled still too often with lint and perchloride of iron : the surgeon is alone, ill equipped, badly lighted.

Take a bandage—a rubber bandage, a strip of ordinary linen, a towel folded like a cravat—place it around the head above the ears, and tie it tightly. There has been obtained a *temporary hæmostasis of the scalp* (*Fig.* 98), which no longer bleeds, and now there is time to deal properly with the situation.

Shave the scalp—the first and a necessary step—soap and brush it, wash it with alcohol or ether; now cleanse the wound over the whole of its large surface, including skull and flap, bathe it with very warm boiled water, remove the clots, hairs, etc.; spare no time in doing the work thoroughly. The whole field is now ready for permanent hæmostasis.

In the margin of the wound can be seen the arterioles, embedded in the dense dermic layer. They can be caught up with Kocher's forceps, but one cannot count on tying them over the forceps; they are too adherent, and the ligatures will slip off. It is the same with the vessels which run over the deep surface of the flap. The principal vessels must therefore be ligatured in the manner we are about to describe; tie as many as possible, and depend upon the sutures for occluding the remainder.

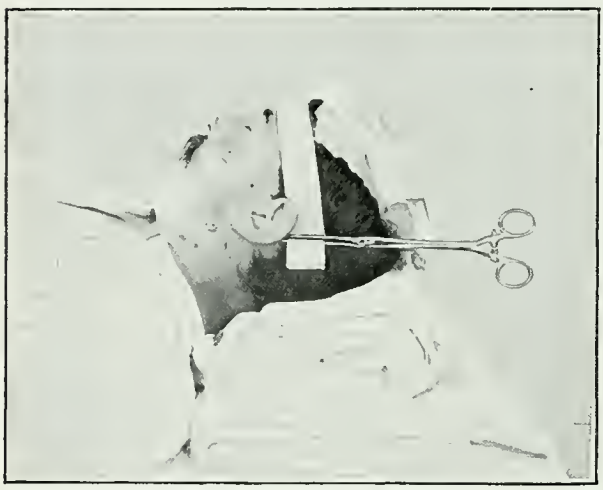


Fig. 98.—Temporary hæmostasis of the scalp.

It is necessary to ligature in continuity, a little behind the bleeding points, towards the base of the flap: in other words, with a curved Reverdin needle or an ordinary curved needle, carry the ligature around the vessel in the derma (*Fig.* 99) and tie it firmly and steadily. The sutures will do the rest if all the large temporal branches are properly tied.

The suture will aim at exactly replacing the stripped-up flap, and covering in the skull, without attempting to secure perfect coaptation of the edges, which is not necessary nor even desirable. A few points of suture, well placed at the angles, will suffice to fix and spread out the flap. When there is considerable stripping up, it is always well to leave a drainage tube in the lower part of the wound, and in cases where a large flap has been torn downwards, an opening for the tube should be cut in its base.

On this primary intervention, with proper disinfection, satisfactory hæmostasis, careful adjustment of the wound edges, and a well-applied dressing, will depend the prevention of complications at one time

considered to be almost the normal sequelæ of such injuries—erysipelas, diffuse suppuration, and secondary hæmorrhage.

The great vitality of the cranial coverings indicates the treatment to be adopted in cases of complete scalping, which occur from time to time in factories. The mechanism is well known. In dealing with a quite recent accident, if the torn-off scalp can be found, it should be replaced. Cut the hair quickly; rapidly but thoroughly cleanse both surfaces of the great flap, and also the surface of the denuded cranium; then replace the scalp on the head, stretch it carefully, spread it out and fix it in position by a few points of suture, and provide for free drainage. This reimplantation has repeatedly succeeded; and even though the scalp should fail to recover its vitality, its presence will serve a useful purpose in protecting and stimulating the process of cicatrization.[1]

This practice is of course especially indicated when the cranial covering still holds by a pedicle, no matter how narrow.

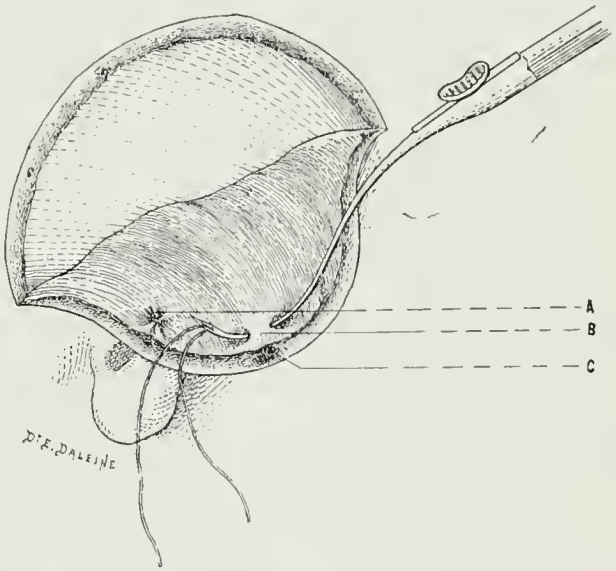


Fig. 99. – Ligature in continuity of an artery of the scalp. (A) Completed ligature. (B) Bridge of tissue with the artery underrun with a Reverdin needle. (C) Gaping mouth of the artery in the edge of the scalp flap.

On the face, bleeding is always considerable, but it can be checked without much trouble; catch with forceps and tie any spouting vessels, then apply pressure for a few minutes: the suture will complete the hæmostasis.

Do not forget, in cases of injury affecting the posterior facial or parotid regions, to determine at once the condition of the facial nerve. Make the patient whistle and close his eyes; a wound of the facial nerve (*Fig.* 104)

[1] This is well shown in a case reported by A. Malherbe. The scalp, comprising all the cranial teguments from the nape of the neck to, and including, the eyebrows, had remained fixed by the hair to a shaft in the laundry where the accident had occurred two hours previously. It was sent for, and after careful disinfection by shaving and brushing with soap and sublimate solution, it was readjusted to the skull and sutured; counter-openings were made at the vertex of the skull, and drainage was provided. The scalp died, but turned into a parchment like covering which remained adherent to the cranium and under which healing took place without any complications. (A. Malherbe, "Un cas de scalp complet traité par la réapplication du cuir chevelu." *Bull. méd.*, 1898, No. 97, p. 1121). In such a case the reapplication is practically only a dressing with the skin.

and the consequent paralysis, even when limited to the superior branch, are very serious complications which it is necessary to observe and mention at once.[1]

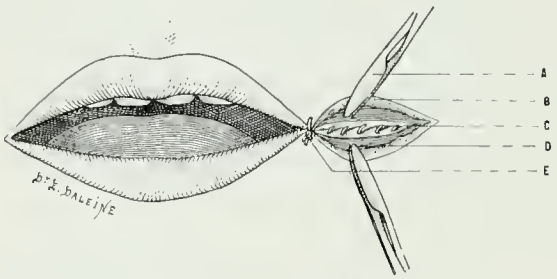


Fig. 100.—Suture of a wound of the angle of the mouth: deep suture. (A) Forceps applied temporarily to the two ends of the cut artery. (B) Margin of skin wound. (C) Continuous suture of the mucous edges. (D) Muscular layer. (E) Commissural suture.

Excluding some large contused and stripped-up wounds, in which only a few points should be introduced, sufficient to hold the flaps in place,[2] the closure should be complete, the sutures being very carefully applied to minimize as far as possible the resulting scar.[3] In certain places special care is demanded: I refer to the eyelids, the nose, and the mouth.

Suture the mucous surfaces carefully, especially at the margins of openings and commissures; this is the general principle, attention to which will prevent the development of any deformities.

With the lids, when completely divided, first of all unite the margins of the mucous surface with a continuous suture of fine catgut (*Fig.* 102), then adjust the free border accurately by a marginal point, taking hold of the tarsal cartilage (*Fig.* 103), and continue the suture on the skin from below upwards.

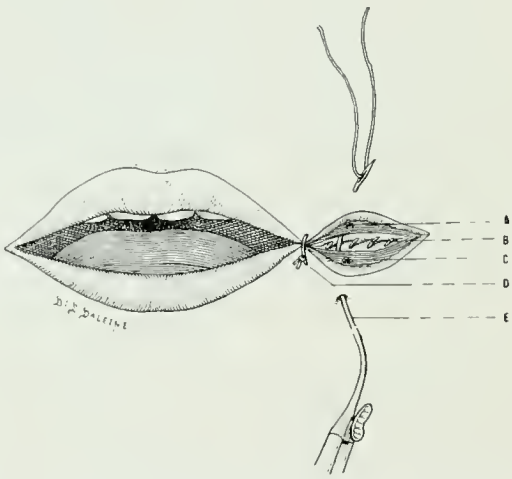


Fig. 101.—Suture of the wound of the angle of the mouth: superficial suture. (A) Muscular layer. (B) Mucous suture. (C) Cut coronary artery. (D) Commissural suture. (E) Needle picking up the skin and muscular layers: hæmostatic sutures.

[1] Nor must the neuralgias be forgotten, or the tic convulsif, which may possibly supervene. Lastly, certain wounds, those of the lower lid or of the nose for example, may produce, by contraction, special troubles—epiphora, atresia of the nares, etc.

[2] The reparative powers of the face tissues are almost without limit; M. H. Kaposi has published a case of complete tearing away of the mask of the face, where in one mass, the lower jaw, the lips, and the skin of the cheeks, the nose, and the middle of the forehead had been carried away; all that could be done was to stop the bleeding, cleanse and carefully dress the enormous wound, and fix forward the tongue, which tended to fall back. Little by little, thanks to Thiersch grafts and repeated operations, such a degree of restoration was obtained that the patient was able to feed himself and make himself understood, by means of a gaping hole, which hid a prosthetic apparatus and acted as a mouth. (H. Kaposi, "Totale Abreissung der Gesichtsmaske." *Beitr. zur klin. Chir.*, 1905, xlv., 2, p. 280.)

[3] The subcuticular suture is useful in these cases. (See Wounds of the Soft Tissues.)

Here is a large **wound of the cheek**, involving the **labial commissure**, a great gash which almost cuts the side of the face in two.

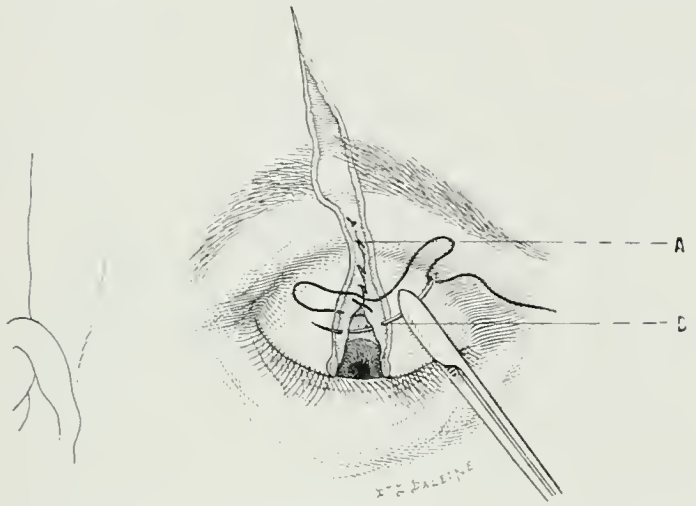


Fig. 102.—Wound of the forehead, eyebrow, and eyelid. (A, B) Continuous catgut suture of the mucous layer.

Compress the two borders, apply a continuous catgut suture to the mucosa, ending at the commissure: at this point place very carefully one or two

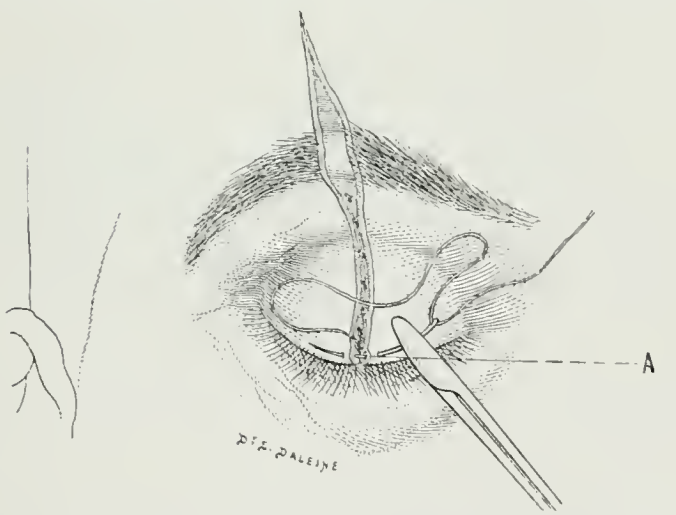


Fig. 103. Wound of the forehead, eyebrow, and eyelid. Skin suture: (A) Marginal suture passing through tarsal cartilage.

interrupted muco-mucous sutures (*Fig.* 100); the mouth is closed, and it only remains to unite the skin by a few interrupted sutures, including all

the tissues down to the mucous lining, passing deeply under the vessels and controlling them (*Fig.* 101).

Another accident is not at all uncommon, both in children and adults. As a result of a violent blow a **lip is split from margin to base**, and is bleeding freely.

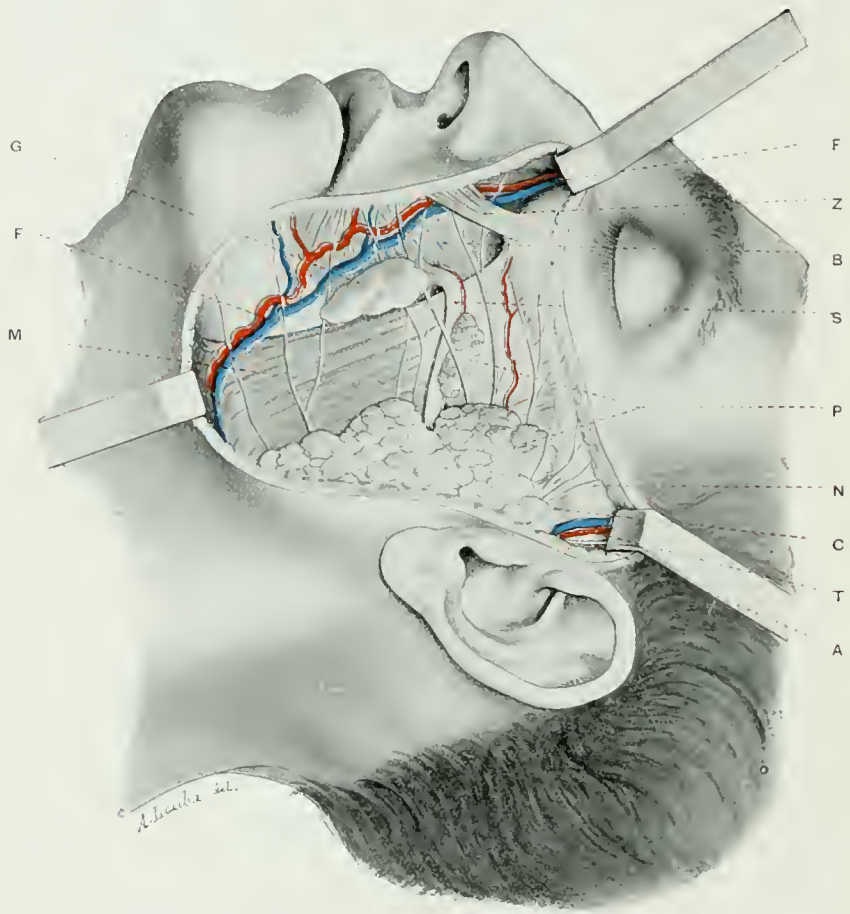


Fig. 104.—The cheek. (A) Auriculo-temporal nerve. (B) Buccinator muscle. (C) Condyle of jaw. (F) Facial artery and vein crossing the lower jaw. (F) Termination of the facial artery and vein. (G) Pad of fat. (M) Masseter muscle. (N) Upper branch of the superior division of the facial nerve. (P) Parotid and accessory parotid glands. (S) Stenson's duct. (T) Superficial temporal artery and vein. (Z) Zygomatic muscle.

Do not attempt to check the bleeding by gauze pressure or the application of forceps, but take hold of the two halves of the cut lip, and compress them between the fingers, when it will stop at once (*Fig.* 105). To reunite the margins satisfactorily, some hæmostatic sutures should first be passed from the cutaneous surface (*Fig.* 106); then, everting the

lip, as shown in *Fig.* 107, finish by suturing the mucosa, paying particular attention to the free border.

A few words only with regard to **wounds of the tongue**, usually

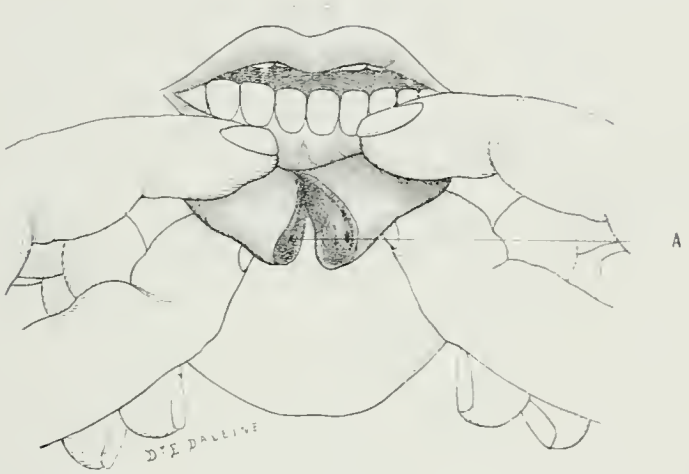


Fig. 105.—Wound of the lip: hæmostasis. The two parts of the split lip held between the fingers. (A) Cut coronary artery.

bites, which may be very serious because of the bleeding. Seize the tongue at once with a pair of forceps and draw it forwards, take one of the edges of the wound between the fingers, apply forceps to the other (*Fig.* 108), then clear the mouth and throat of clots, to see plainly and enable a good suture to be made.

The suture is usually depended upon for controlling the bleeding: the threads must therefore be passed through the whole thickness of the tongue at right angles to the line of the wound; work towards the free margin, and tie the sutures as they are passed (*Fig.* 109).[1]

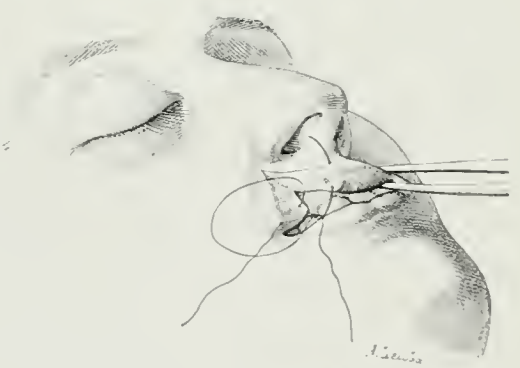


Fig. 106. Wound of the lip: cutaneous suture.

Wounds of the palate, hard or soft, are most commonly seen in children, who fall down, head forwards, while holding some pointed article in the mouth.

[1] Longitudinal wounds of the tongue may also at times be seen, even a division of the organ into two halves: here again immediate coaptation by means of deep hæmostatic sutures is required.

These wounds are often limited to irregular tears of the mucous covering of the palate, but they may be penetrating, the palatine vault being perforated by the foreign body, which penetrates into the nasal fossæ or even to the base of the skull.

Fig. 107.—Wound of the lip: mucous suture.

They always bleed badly, and the first indication is to examine the wound thoroughly. The best plan usually is to put the little patient at once in the inclined position, with the head hanging over the end of the table, and if necessary give some chloroform: then only, and with the mouth widely opened, is it possible to examine the whole of the palate. If the injury has implicated only the mucous surface, it is well, if the necessary instruments are available, to introduce a few sutures which will control the bleeding; if there is a comminuted fracture or a perforation of the palate, it must be cleansed, and a strip of aseptic gauze packed into the opening, the nasal fossa being also packed.

This hæmostatic packing must be removed at the end of thirty-six or forty-eight hours, and frequent douching of the nasal cavity be instituted.[1]

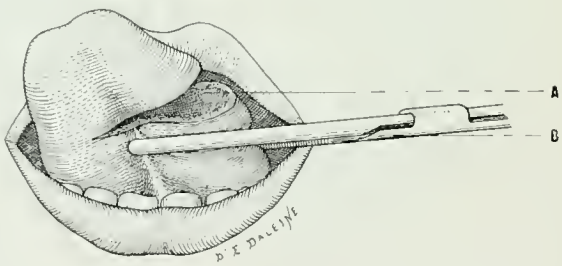


Fig. 108.—Wound of the tongue: hæmostasis. (A) Open wound. (B) Clamp compressing the margin of the posterior segment.

Lastly, we may here mention the **serious hæmorrhages which sometimes follow tonsillotomy.** Forceps pressure[2] cannot be depended on to stop the bleeding, still less the various so-called hæmostatics; if any 5 per cent solution of gelatin (see EPISTAXIS) is at hand,

[1] After injuries or operations on the naso-buccal region in children, and also with adults in a depressed condition, beware of those slow and continuous hæmorrhages which flow into the pharynx or œsophagus and accumulate in the stomach: persistent pallor should always make one uneasy, and cause an examination of the back of the throat to be made.

[2] A proper tonsil compressor is not usually at hand: to use a long and powerful clamp, with one blade in the mouth and the other on the cheek, is a rough method, which should be reserved for cases in which it is necessary to control hæmorrhage due to a wound of a large vessel.

or can be obtained quickly, plastering this freely over the bleeding surface may be tried; if not, or in case of having to wait, compress the cut tonsil with a large swab held in a pair of forceps.

The finger is often the most useful compressor: the index, left or right, is applied firmly to the bleeding point, while the fingers of the other hand, placed behind the angle of the jaw, exercise an external counter-pressure: the compression must as a rule be continued for a considerable time.

If the hæmorrhage does not yield to these measures, M. Escat's plan may be adopted[1]: a pledget of gauze is packed firmly into the tonsil socket and retained in place by suturing the anterior and posterior pillars of the fauces together over it.

Some other hæmorrhages occur in the bucco-facial region, which may, by their severity and persistence, necessitate the immediate application of certain ligatures: for instance, in some ulcerated cancers of the tongue. We were called one night to see a comparatively young man, suffering from a cancer of the tongue, and who had for some hours been losing considerable quantities of blood; warm injections, ice, caustics, the cautery, local compression, had all been tried, with no lasting benefit, while the livid pallor and feeble flying pulse indicated a dangerous condition of acute anæmia. Forthwith we ligatured the two lingual arteries above the great cornu of the hyoid bone: the bleeding at once ceased, and the patient lived for several months.

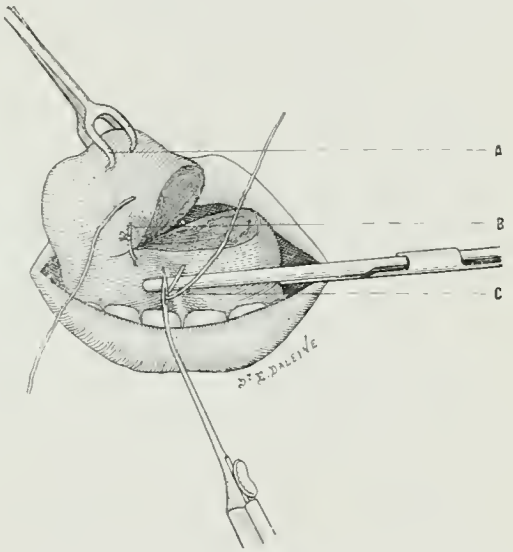


Fig. 109.—Wound of the tongue: suture. (A) Forceps drawing the tongue forwards. (B) First suture at the deep angle of the wound. (C) Second suture passing through the whole thickness of the tongue.

It is therefore useful to know **how to tie the lingual artery**, and where—that is, behind the point at which the dorsal branch originates, above the hyoid bone. To do this, make an incision half an inch above, and parallel to, the hyoid bone, from the anterior border of the sterno-mastoid behind to the middle line in front; cut down at once to the submaxillary gland, dividing the skin, the platysma, the cervical fascia: free the gland below and behind, and turn it upwards with a retractor (*Fig.* 110).

[1] Escat, "Arrêt d'une hémorragie tonsillaire par suture des piliers et tampon sous-jacent. *Revue hebd. de laryngol., d'otol., et de rhinol.*, Sept., 1902. *See also* Neumann, "Zur Blutstillung nach Tonsillotomie." *Arch. f. Laryng. und Rhin.*, 1902, t. xii., p. 467.

Then, working in the posterior part of the wound, expose the two landmarks definitely by blunt dissection: the great cornu of the hyoid bone below, and the posterior belly of the digastric muscle—with the stylo-hyoid—above: in this triangle the artery will be found quite close to the hyoid bone. Now fix the great cornu with a blunt hook (Cooper's needle) and, immediately above it, carefully incise the muscular sheet with vertically-placed fibres (the hyoglossus): it is often better to first separate the muscular fibres vertically with the end of a grooved director, and as soon as the little bundle of vessels is seen, to enlarge the opening transversely on the director slipped in front and behind under the muscle fibres. This is the critical step of the operation: the artery is always more superficial than one thinks: if it is not exposed by the first search, take care not to get too deep: the hyoglossus muscle is always rather thin, and the muscular fibres which we are now separating are those of the middle constrictor: if one persists the wall of the pharynx will be laid bare and perhaps perforated. Go backwards to the level of the tip of the great cornu, and there, above it, seek the trunk of the artery before it passes under the hyoglossus. The vessel must always be tied as far back as possible.

FIG. 110.—Ligature of the lingual artery above the great cornu of the hyoid bone.

Should one still fail to find the lingual, then prolong the incision backwards, expose and retract the sterno-mastoid, and, following the great cornu of the hyoid bone, look for the external carotid.

Ligature of the external carotid artery is indeed the usual resource in dealing with obstinate hæmorrhages from the face or the facial cavities: the method of performing the operation ought to be well known.

Turn the patient's head to the opposite side, and have it held in that position. Palpate the angle of the jaw, the anterior projecting border of the sterno-mastoid, the great cornu of the hyoid bone: the last will be the best guide. Make a three-inch incision along the anterior border of the sternomastoid, with the upper end lying behind the angle of the jaw, and cut down boldly on to the red muscular border, which, before anything else is done, is freed by blunt dissection and retracted outwards. Place another retractor on the anterior margin of the wound, and then expose the great cornu, free the extremity definitely, and keep it in sight: it corresponds posteriorly to the vessel sought. Feel for the arterial pulsation, and then proceed to expose the artery by blunt dissection. Usually a fairly large vein is first encountered, which in front divides into several branches: this is the thyro-linguo-facial trunk; it crosses the

artery: isolate it. Higher up, at a somewhat variable distance, find the large hypoglossal nerve, which also crosses the artery: it is between the venous trunk and the nerve that the classical ligature is practised. Keep that in mind: follow closely the vein or the nerve if they present themselves readily: but if not, do not insist on finding them: if the veins give trouble, retract them or divide them between two pairs of forceps: work towards the pulsating vessel in the depths of the wound, expose it cautiously, take the most anterior of the two arteries—the one nearest the great cornu—that which has branches springing from its anterior border,—pass the ligature from behind forwards above the first branch, the superior thyroid; make sure of being in good position, then tie.

After some serious injuries of the mouth and tongue, certain complicated fractures of the jaws, or again in cases of prolonged trismus, it may be necessary to administer **nourishment by means of the nasal tube**, introduced by the anterior nares and pushed on into the stomach.

Fig. 111.—Ligature of the external carotid artery.

The tube is of very flexible gum-elastic or thick rubber, with an internal diameter of a quarter of an inch and a length of about thirty-six inches. It may be introduced with the patient recumbent, but more easily in the sitting position. Take a position in front of the patient, whose head, inclined slightly backwards, is steadied by an assistant: pass the tube, lubricated with sterilized oil, into one of the anterior nasal openings (*Fig.* 112), slip it along the floor of the cavity, in contact with the septum; the tube is checked by the posterior wall of the pharynx: push gently: the resistance soon yields, and the slow, steady pushing on of the tube is continued: see that the head is kept well fixed and not allowed to bend forward; also tell the patient to try to swallow the tube.

The difficult stage is in the pharyngo-laryngeal region: the struggles of the patient and the blueness of his face may show that the end of the tube has insinuated itself into the larynx; pull it backwards at once, wait an instant, then begin to feel the way again, pushing the tube on little by little. Once the introduction is completed, it only remains to adapt a funnel to the outer end of the tube and to pour in slowly the desired

quantity of fluid; lastly, withdraw the tube, taking care to occlude the exterior opening with the thumb while doing so.

In some cases, where the introduction is very difficult, the tube may be left in position, fixed by a double thread tied around the head; but it is preferable to repeat the proceeding twice daily.

Fig. 112.—Introducing the nasal feeding tube.

FRACTURES OF THE BONES OF THE FACE.

This group of fractures deserves special attention, first, because they usually communicate with the naso-buccal cavity, and are therefore peculiarly liable to septic complications, and next because of the disfigurement they produce and the great difficulty often associated with retention after replacement of the fragments.

Fractures of the Bones of the Nose.—In order that these may not be overlooked, make it a rule to search for them in every case of facial injury. Sometimes, indeed, the deformity is evident at the first glance, the external framework of the nose being flattened, driven in, or presenting a deep groove across the root, probably associated with two black eyes, or displaced quite evidently to one side. It may happen,

however, that diffuse swelling and œdema of the face hides any deformity. Nasal hæmorrhage is constant in these cases, but is, as we know, of doubtful significance. Carry the finger from below upwards, along first one, then the other side of the nose: an acute pain, a point which yields, or some crepitation, reveals the fracture under the thick layer of œdema. Or again, grasp the root of the nose between the forefinger and thumb of the left hand, and with the right hand try to move it laterally.

Often there is nothing to be done; if the deformity is slight, daily nasal douches and massage will suffice. When, however, there is depression, partial or total, it is necessary to raise the fragments and to restore as far as possible the shape of the organ and the normal permeability of the passages. Introduce a closed pair of forceps or a director into the nasal fossa, with it lift up the fragments, and from the outside endeavour to mould them into position. It is often inadvisable to try for an absolutely perfect cosmetic result at the first attempt; if successful in getting the bones into fairly good position, which they seem likely to retain, one may rest satisfied for the time; a little later, when the broken framework has recovered some degree of cohesion, the restoration may be completed with less risk of ruining the scaffolding.

When the breakage has been very extensive, when the cartilaginous septum is broken and the structures refuse to hold in position, it is useful, after free douching, to pack the nasal fossæ, so providing the necessary support; the packing must not be allowed to remain very long. Here again massage will be useful in the after-treatment.

Fractures of the Upper Jaw.—These may be *partial*, involving a segment of the alveolar border, which must be restored to position and retained by one of the methods which we shall presently describe when speaking of fractures of the lower jaw. Other parts of the bone may also be involved: when the wall of the antrum (especially the anterior wall) is affected, the lesion is characterized by the development of *emphysema of the cheek and lower lid*, which may spread widely, but is usually without serious import and quickly disappears.

Complete fractures are of varied types, but possess some practical indications in common. It may only be possible to detect them by a very close examination; therefore do not fail to explore with the finger the outer buccal surface of the bone, the palatine vault, and, quite at the back, the inner surface of the pterygoid process; at the last point pressure will often elicit a characteristic pain, indicating the transverse submalar fracture (usually bilateral) of Alphonse Guérin. Apply the fingers and thumb of the left hand firmly to the two malar bones, and with the right, by way of the mouth, take hold of the maxilla—the fingers on the palate and the thumb in the canine fossa—and try for mobility.

More often, however, the fragments are widely separated, and the bone, depressed or splintered, presents an extensive area of comminuted fracture opening into the mouth and the nasal fossæ, and sometimes also to the exterior, the skin having been divided over the bony projections. One cannot expect in such a case to be able at once to restore the parts to their

proper position, nor is it possible to formulate in advance methods of reduction which will suit any particular case. Some general principles may, however, be laid down: Guard against doing too much at first in dealing with the fractured bone; do not remove the fragments or splinters more than is absolutely necessary; even though almost completely detached, they may retain their vitality and "take" again; to remove them at once is to run a risk of removing too much and of aggravating the subsequent deformities.

Suture the skin wounds if there are any; *hæmorrhage* primarily and *infection* later are the principal troubles to be feared and combated; hæmorrhage will sometimes necessitate gauze packing of the focus of fracture or the antrum by the mouth. The packing must not remain longer than is absolutely necessary—two or three days as a rule;—and remembering that infection[1] is the chief cause of secondary hæmorrhage, naso-buccal douches must be employed, repeated many times daily, with solution of chloral or hydrogen peroxide, or simply with warm boiled water. This douching is the best, and indeed the only, means of preventing and treating secondary suppuration, complicated by the necrosis and general infection which so often follow extensive injuries of the upper jaws.[2]

Lastly, certain forms of improvised apparatus, similar to those we shall describe in the following pages, may subsequently be applied, and will assist functional restoration; too much must not, however, be expected from their use.

Fractures of the Lower Jaw.—These are often serious and always difficult to treat. Here again, the open communication of the fracture with the cavity of the mouth involves the well known risk of septic complications: locally, suppurative periostitis, diffuse submaxillary abscess, extensive necrosis; generally, septicæmia, which may be fatal. Further, it is very difficult in most cases to maintain the fragments in accurate apposition; it is not sufficient to secure solid union or even a good cosmetic result; the functional result is only completely satisfactory when the restoration of the alveolar border allows the teeth of the lower jaw to renew their normal articulation with those of the upper set.

When we add that certain forms of retentive apparatus, excellent though they be, require a special equipment and special skill for their manufacture, and are not of general application, it will be easily understood that a fracture of the lower jaw may often be badly treated and become a source of great difficulty and worry to the isolated practitioner.

Suppose we have to treat a fracture of the left side of the body of the mandible—a fracture oblique from above downwards and from before backwards; the gap on the alveolar border shows itself between the canine and the lateral incisor, the dental line presents an abrupt

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[1] "Packing implies suppuration," said Verneuil. How many times has the aphorism been verified.

[2] This must always be taken into account in the prognosis. It is also to be remembered that some fractures, even when partial, may be followed by persistent infra-orbital neuralgia, or stenosis of the nasal duct.

projection, and the posterior fragment overrides more or less. What can we do?

First of all, do not think of the complicated chin bandages, or of those instruments of torture, constructed with difficulty and always of doubtful value, which keep the mouth closed and interfere in such an awkward manner with feeding and the hygiene of the mouth. Remember that the primary indication in fractures of the lower jaw is for frequently repeated and thorough disinfection of the mouth.

Apply Claude Martin's simple apparatus,[1] which consists of an elastic sling and an interdental wedge, and with other merits possesses that of being readily improvised.

It is based on the fact that in a fracture of the lower jaw into two fragments, when the mouth is opened, "**the posterior fragment is automatically depressed and tends to place itself in correct apposition to the anterior one. The fracture is therefore, so to speak, spontaneously reduced.**" Open the mouth widely, place a wedge of wood or cork between the posterior fragment and the corresponding portion of the dental arch of the superior maxilla, then apply an elastic band, two inches wide, under and projecting a little in front of the chin, and fastened over the head. That is the "open mouth" position, somewhat embarrassing certainly, but tolerable, and by this very simple arrangement the fragments can be kept in position.

At meal times the wedges will be temporarily removed. They may also be removed from time to time, if necessary, until the patient gets accustomed to their presence, but as seldom as possible. The chin support must remain constantly in position. Lastly, passive movements and massage should be commenced at once.[2] When dealing with a bilateral fracture, with depression of the intermediate fragment, two interdental wedges must be introduced and the elastic band fitted as before.

With a fracture which presents little difficulty in reduction, and a docile patient, this apparatus may suffice.

When, however, the fracture is not easily reduced, or after reduction is kept in position with difficulty, if the fragments are multiple, the elastic band should again be employed as a temporary measure, but in order to insure a perfect restoration of alignment to the masticating surfaces of the teeth, an interdental gutter-splint becomes necessary. These splints have only one defect in the conditions we are now considering—the necessity for a special technique and the assistance of a skilled dentist.

If such a resource should be out of reach, or at any rate might involve a long delay, one may employ ligature of the teeth, or again, if one has the necessary materials, a guttapercha moulded splint.

[1] Claude Martin, "De la simplification des méthodes de traitement des fractures du maxillaire inférieur," Lyon, 1899.

[2] One may in certain cases dispense with the interdental wedge, and after reduction be content with applying an elastic bandage, some turns (submental-bregmatic) passing vertically and others (suboccipito-mental) horizontally. (M. Ponroy, "Traitement des fractures du maxillaire inférieur par la bande élastique," *Thèse de Paris*, 1903.)

The simplest method of applying the ligature consists in encircling the crowns of the two teeth on each side of the line of fracture with a silver wire, which is then twisted sufficiently to hold the two fragments as accurately in apposition as possible (*Fig.* 113). This is not, however, a method to be generally recommended; it is sometimes impossible, when the teeth are too closely placed or overlapping, to permit a sufficiently strong wire to be passed between them; it is often painful; very often the wire slips, compresses and ulcerates the gum, loosens the teeth, and, while ceasing to exercise any useful constriction, becomes a starting point for further complications.

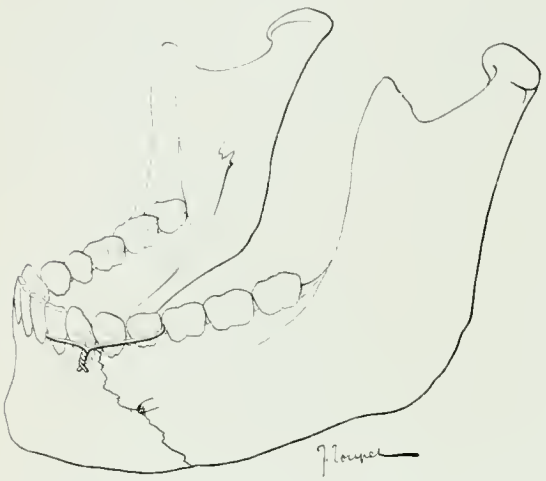


Fig. 113.—Fracture of the lower jaw. Ligature of the four adjacent teeth.

It is much better to apply the wire in trellis fashion around the whole of the teeth of the lower set. A heavy silver wire is moulded around the whole row, passing behind the two posterior molars; a series of antero-posterior loops of fine wire unite the two portions of the main wire; lastly, it is fixed to the teeth immediately on either side of the fracture and to other teeth from place to place by loops of fine wire, encircling it and the crowns of some of the teeth (*Fig.* 114). In this way a fairly satisfactory apparatus is obtained, which is, however, rather difficult to fit.

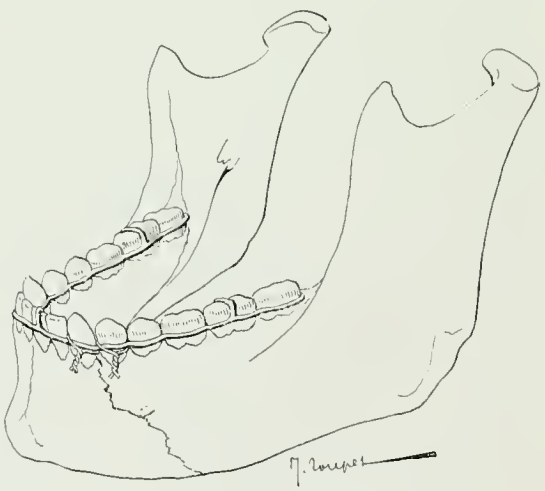


Fig. 114.—Fracture of the lower jaw. Fixation of the alveolar arch by means of a wire framework.

A moulded gutter which will be useful, at least temporarily, may be made with guttapercha. Cut a strip of guttapercha long enough to cover all the arch on the affected side and sufficiently broad to overlap the teeth; immerse it in hot water until it is perfectly soft and malleable;

the fracture being reduced, apply the strip, fold it over the teeth gutter fashion, mould it to them as closely as possible and hold it in position until it hardens. It is not a simple gutter that has to be made, but a mould which follows closely the contour of the teeth in all their irregularities, and is depressed into their interstices; the apparatus will only be of value in retaining the fragments in position if these conditions are fulfilled. I may add that it is always irksome to wear, being too thick, that it excites profuse salivation, and that often it speedily loses its shape under the pressure of the upper teeth, and has therefore only a very temporary usefulness. However, if well made, it will in favourable conditions give results which are not to be despised, as I have on two occasions been able to convince myself.

The continuous application of the elastic band under the chin will always be combined with these means of direct fixation, and also with the dental splints. Making and applying a dental splint require the following steps: Taking an impression of the mouth—upper and lower jaws; making a cast from the impression, and on it reducing the fracture perfectly by adapting the pieces of the inferior cast to the teeth of the upper; making from the reconstructed cast the fixation apparatus, or splint; applying the splint to the dental arch.

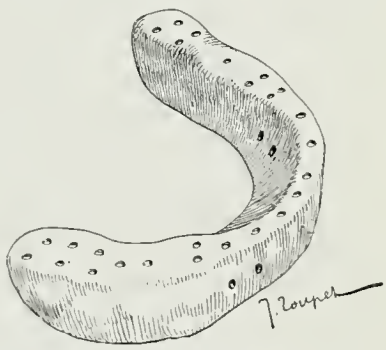


Fig. 115.—Simple gutter splint for fixation of a fractured lower jaw.

Splints are usually of vulcanite, or some one of the various dental alloys; the simple gutter (*Fig.* 115) is suitable for the less difficult cases with a single or at most a double line of fracture.

When the fragments are more numerous, and difficult to keep in position, the splint may have to be completed by the addition of metal bands screwed to the fragments; such an apparatus must naturally be made and fitted by a specialist.

We now come to the Question of Suture.—This is indicated in cases of fracture with an external wound, in cases where the jaw is without teeth or with teeth too few or too loosely fixed to allow the fitting of any of the forms of apparatus which we have just considered, and also for the same reasons in *young patients with undeveloped jaws.*

Properly executed, it ensures satisfactory union of the fragments: its defect—and it is a very real one—is that it does not always result in that perfect adjustment which restores the pre-existing articulation of the teeth. That is not, however, an unavoidable defect; we think that it can be overcome if very special care is exercised.

The operation is performed from without, the wire being placed as far from the interior of the mouth as possible.

Make an incision 1½ in. to 2 in. long, with its mid-point opposite the

seat of fracture, along the lower border of the jaw; go straight down to the bone, and with the elevator raise the periosteum from below upwards, freely exposing the two fragments and the intervening fracture.

Now endeavour to get *exact apposition*: do not hurry, but take time in carrying out this step, the most important in the whole operation. While adapting the fragments, let an assistant gently retract the lip and cheek, that the teeth may be seen, for it is by them the correct position must be determined. On no account cut away any of the projections of the fractured surfaces; the various irregularities must be fitted together just as they are. When the fragments have thus been got into good position, care must be taken that they are kept accurately fixed (*Fig.* 116) while the holes are bored.

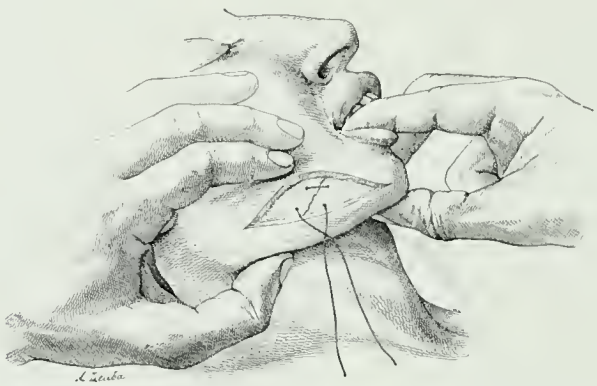


Fig. 116.—Wiring a fractured lower jaw. Holding the replaced fragments in position.

Later (See Operative Treatment of Fractures) we shall have occasion to point out that a bone suture, to be efficient, must be at right angles to the line of fracture; do not forget this fundamental rule. Therefore the two holes will only be placed in the same horizontal line in those comparatively rare cases in which the jaw is broken vertically; on the other hand, in the more common oblique fractures, one of the holes must be on a higher level than the other, the difference varying with the obliquity of the line of fracture.

Various forms of bone-boring instruments will be described later; in default of a dental engine, an ordinary bone awl is quite satisfactory; the bone will always be completely perforated from without inwards.

Introduce the wire—silver or aluminium-bronze of medium thickness, —tighten it against the deep surface of the bone, verify, and if necessary rectify, the position of the fragments, then twist the two ends.

In the great majority of cases the wire should ultimately be removed. Turn down and flatten out the twisted ends, draw the periosteum over the bone, and suture the extremities of the wound, leaving a mesh of aseptic gauze at the centre.

DISLOCATIONS OF THE LOWER JAW.

Whatever may be the real value of the theory which supposes that the obstacle preventing reduction in these cases is the engagement of the coronoid process in front of the malar bone, it remains nevertheless the best guide for treatment; try to disengage the coronoid process: in other words, **first depress the jaw, then push it backwards.**

The patient is seated on a chair in front of the operator, his head resting against the chest of an assistant, who fixes it between his two hands. Wrap pieces of gauze round the thumbs, introduce them into the patient's mouth, and place them as far back as possible on the alveolar arches, on the molar teeth; the fingers encircle the angle of the jaw on either side, and in this manner the bone is held firmly at the junction of the body and the rami.

Fig. 117.—Reducing a dislocation of the lower jaw.

Now the opening of the mouth is increased a little by depressing the chin, and pressing firmly with the thumbs in a downward direction. Do not be afraid of prolonging this first step, and endeavour to exert the pressure close to the vertical limb of the bone along the line of its anterior border. Then push backwards while raising the chin (*Fig.* 117). It is at the end of the first stage that the reduction is brought about, or at least indicated by a sensation of yielding, sometimes very definite; it is completed automatically during the second stage; in other words, it is the manœuvre of "disengaging" which is important, and on which it is necessary to insist

In cases of bilateral dislocation, it is sometimes of advantage to concentrate the efforts, first on one side, then on the other, so effecting successive reduction of the two condyles.

In some cases it is easier to effect reduction with the patient in the recumbent position. Such at least was my experience in a case of right unilateral dislocation which had resisted numerous methodical attempts made by two different surgeons; the patient was laid on a low bed, the head well fixed; I placed my thumbs on the posterior molars and pressed downwards and backwards, at the same time raising the chin a little; reduction, which I also had previously failed to obtain in the ordinary position, occurred at the first attempt with remarkable facility.

I need scarcely mention the method of reduction with the aid of a fulcrum in the mouth, which consists in introducing between the two dental arches, upper and lower, the handle of an instrument, a gag, etc., and then forcibly raising the chin.

Apart from the fact that the method is very painful and injurious to the teeth, its results are very uncertain, chiefly because it is difficult to keep the inter-alveolar fulcrum sufficiently far back to allow of the pressure on the chin producing the maximum useful effect.

Finally, general anæsthesia remains as a valuable resource in certain cases.

SOME POINTS IN URGENT SURGERY OF THE EYES.

I say some points advisedly, because it is not possible to enter into all the details of ophthalmic practice, and we must limit ourselves to a short study of some procedures of extreme urgency, which any practitioner may have to undertake in dealing with **foreign bodies** in the eye, **burns, wounds,** or **ruptures of the eyeball,** in cases of **ocular suppuration,** or in some of the very acute forms of **glaucoma.**

Foreign Bodies.—Those in the conjunctiva and cornea specially demand our attention. Foreign bodies in the anterior chamber, the iris, the lens, and above all, in the posterior segment of the globe—often difficult to discover and extremely difficult to extract—as a general rule only demand primarily the aseptic attention of which we shall subsequently speak.

Cocaine is of the greatest value in these cases: it prevents unnecessary pain, and irritating or dangerous examinations; it is essential, however, that the solution should be fresh.

Introduce a few drops of a 5 per cent solution into the conjunctival sac, wait one or two minutes, and then, applying a blunt slender rod, pencil, or probe, transversely under the upper margin of the orbit, gently take hold of the lashes and the ciliary border and evert the upper lid. Almost invariably the foreign body will be found—a grain of dust, speck of coal, etc.—on the under surface of the lid at the level of the tarsal zone,[1] and may

[1] Certain little bodies in the form of hollow hemispheres (husks of millet seed, wing cases of coleoptera), met with particularly in summer, fix themselves usually near the sclero-corneal junction and adhere closely; without careful examination one might readily take the little central yellow spot surrounded by red for a phlyctenule. (Valude, "Diagnostic et traitement des corps étrangers oculaires," *Bulletin méd.*, 1901, No. 100, p. 1060; and "Accidents oculaires du travail: les corps étrangers," *Ibid.*, 24 février, 1906, p. 179.)

be removed readily with a spill of paper, or a small bit of cotton on the end of a probe. The task becomes somewhat more difficult in cases where very fine dust is adherent and perhaps already buried in the swollen conjunctiva, its position being indicated by a red areola. If firmly fixed, it may be dug out with the point of a cataract needle, or a tiny piece of the mucosa, with the foreign body at the centre, may be excised with fine curved scissors.[1]

If the foreign body is on the cornea, the little operation is always a more delicate one, and the discovery of the offending particle itself is often difficult. A good oblique light is necessary, and focal illumination with a lens often useful.

The eye being well cocainized, the operator should place himself behind the seated patient, whose head is firmly held. With the left hand hold the lids apart.[2] and with the right, using a small curette (*Fig.* 118), or a cataract needle (*Fig.* 119), enucleate the foreign body: keep the needle parallel to the corneal surface, and do not allow the point to penetrate the tissues.

When a body of some length has been driven obliquely into the cornea, the best plan is to transfix the tissues immediately in front of it with a cutting needle, and to divide them from within outwards; the way is then open, and the extraction can be completed as before. Some degree of deftness of hand is required for this little operation, and it is necessary in the attempts at extraction *to guard against pushing a foreign body primarily embedded in the cornea into the anterior chamber.*[3]

Fig. 118. *Fig* 119. *Fig.* 120.

Fig. 118.—Curette for removing foreign bodies.
Fig. 119.—Cataract needle.
Fig. 120.—V. Graefe's knife.

For removing particles of metal, the magnet is most useful; an ordinary magnet answers perfectly well for small superficial bodies. The electro-magnets are not often included in an ordinary equipment. I need only remind the reader of their value in removing intra-ocular metallic fragments.

[1] One may sometimes find in the conjunctival sac, particularly in children, a comparatively large foreign body which has remained there for a long time, even for years: Froelich removed a piece of a branch of a pear tree which had lain for twelve years in the left conjunctival surrounded by granulations. ("A propos des corps étrangers de la conjonctive," *Revue méd. de la Suisse romande*, 1893, t. xiii., p. 378.)

[2] Or use an eyelid retractor.

[3] Sometimes it is better, particularly in the case of a spicule implanted perpendicularly to the corneal surface, to adopt the following plan: incise the cornea near its margin with a Graefe knife (*Fig.* 120), make the cut very slowly to prevent the abrupt escape of the aqueous humour and possible protrusion of the iris, and then endeavour to remove the body with curved iris forceps by this opening; or again, a spatula may be introduced to support the spicule from behind or to push it forwards while being removed from the front.

These intra-ocular foreign bodies, when they occupy the anterior chamber or are driven into the iris or the lens, can usually be recognized without trouble, and their immediate extraction is indicated, especially if it is possible to remove them by the already existing wound, enlarged a little if need be, to allow of the introduction of a fine pair of forceps, a curette, or a magnetized rod; if the body is impacted in the iris, it is advisable to remove the affected segment.

Foreign bodies in the lens are disengaged with difficulty, and often necessitate the immediate extraction of the traumatic cataract which has been produced.

When foreign bodies are lodged in the posterior portion of the eye, vitreous, choroid, or retina, the accurate determination of their precise situation almost always requires a radiographic examination[1] and for their extraction[2] a special equipment and very delicate manipulations are needed. In ordinary practice, interference should be limited to obtaining and maintaining rigorous asepsis of the wounded eye. This rule holds good in particular for small lead shot.[3] Immediate careful lavage of the conjunctiva with warm boiled water, repeated several times daily, absolute rest, and occlusion of the eye under a moist sterile dressing, meet all the indications: if these precautions are properly and perseveringly observed, they will often prevent the development of any complications.[4]

Burns.—We need only mention those deep and serious burns which destroy the eyeball and are usually associated with similar lesions of the lids and face; they sometimes necessitate immediate or early enucleation of the eyeball. (See *later*).

Burns of the conjunctiva, cornea, and sclerotic are common, especially in industrial districts; they are due to the action on the eyes of acids (vitriol, etc.), caustic potash or soda, quicklime, a droplet of molten metal (iron, steel, brass, lead, tin, etc.), or a hot particle of metal. Bathe the eye at once and freely with warm water, separating the lids as widely as possible; if one has to do with the effects of an acid, a 1 per cent solution of bicarbonate of soda is very useful for washing out the conjunctival sac; after corrosion by an alkali, use a solution of boracic acid,

[1] Blood effused into the anterior chamber, or the vitreous humour, prevents the use of the ophthalmoscope.

[2] Extraction is, however, by no means always indicated; if the injury is recent, and the foreign body potentially magnetic, and an electro-magnet available, extraction may be attempted. If the foreign body is not magnetic, an immediate search is difficult and of doubtful value. Finally, if the injury is several days old, and the foreign body is not causing irritation, expectant treatment is indicated as a general rule. (See Valude, *loc. cit.*).

[3] Neither does the shot always remain in the eye; it may have tunnelled the sclerotic without perforating it; it may also, and this is what commonly happens, have passed through the eyeball and lodged in the back part of the orbit. Within the eyeball, it most often falls to the lower part of the ciliary region (A. Terson).

[4] Of 35 cases of injuries of the eyeball with small shot, treated on these lines, Fornatola succeeded in 32 in preventing sympathetic ophthalmia and preserving the eye. In three cases only did secondary enucleation become necessary. (*Communication au Congrès des sciences médic. de Rome*, 1894, and *Revue générale d'ophthalmologie*, 1894, p. 209). (See also Valois. "Blessures de l'œil par grains de plomb," *Thèse de doctorat*, 1895–1896).

Lastly, when called on to deal with an injury of longer standing, which has been badly treated or not treated at all, with threatening symptoms of cyclitis or intra-ocular suppuration, immediate intervention is urgently necessary: enucleate the eyeball in the first case, to prevent the development of sympathetic ophthalmitis; eviscerate and curette it in the second. (See *later*).

or if there is none at hand, use milk: for burns caused by quicklime, oil is to be recommended, or better perhaps, a concentrated solution of sugar, the use of which should be continued.

As soon as the most urgent indications for bathing the eyes and neutralizing the corrosive agent have been met, the eye should be cocainized and examined very carefully, any foreign bodies which may be present should be removed, and note taken of the lesions.

If the cornea is wrinkled, greyish or yellowish, if any segment of the sclerotic has already assumed a similar appearance, the development of a perforating slough and the ultimate loss of the eye may be expected. This is, indeed, the great danger.[1] and frequently it is quite impossible at the first examination to be sure how far the necrosis may extend.

Do not prolong the examination unduly: give a last lavage with a 1–2000 solution of biniodide of mercury or boiled water, cleanse the lids, the eyebrow and the peri-orbital region, cover up the eye with sterile compresses moistened with cold boiled water, and put the patient to bed in a dark room.

Wounds and Ruptures.—In all injuries of the eyeball the immediate therapeutic measures should have two chief objectives: conservation and asepsis; any primary action should be limited to sclero-conjunctival suture, reduction, excision or cauterization of a prolapsed iris, or perhaps nothing more than the extraction of a dislocated lens.[2]

After disinfecting the hands, begin by making a careful examination of the injured eye; carefully cleanse all the peri-orbital and palpebral region with tepid boiled soapy water, avoiding any pressure or any abrupt movement (which might seriously aggravate the ocular lesions), evert the margins of the lids, bathe them also, and then introduce a few drops of a solution of cocaine. The anæsthesia will make it possible to open the lids and cleanse the conjunctival sac and front of the eyeball by means of a gentle stream of lukewarm boiled water or of a very weak solution (1–4000) of perchloride or biniodide of mercury.[3]

Examine the wound in the eye with the assistance of oblique illumination: be thoroughly satisfied as to the absence of foreign bodies; and

[1] Other dangers are: the effects of ocular suppuration, keratitis, hypopyon, panophthalmitis; later, adhesions between the globe and the lids, due to cicatricial fusion, more or less extensive, of the ocular and palpebral conjunctiva (symblepharon, partial or complete, entropion, trichiasis, obliteration of the lacrymal puncta). If the conjunctival fornices are intact, it is always a favourable element in the prognosis, as the adhesions will be partial and more easy to treat.

[2] There is a very rare injury which deserves a passing mention—*a dislocation of the eyeball*, pushed completely outside the orbit, and prevented from returning by the contraction of the lids behind it. If it is certain that the optic nerve is torn, the best plan is to complete the division of the muscular bands and simply remove the eye, particularly if the accident had occurred some hours previously, and the dislocated eye and the wound in the orbit had in the interval remained exposed to infection. If the optic nerve is intact, the eyeball and the wound will be carefully disinfected with a suitable antiseptic solution, and you may then proceed to reduce the eye. The lids must be retracted to the maximum degree possible, and if that does not give sufficient room the external commissure must be divided: then the globe will be gently pressed backwards, and as soon as it passes the palpebral barrier it will slip into its proper place. If the dislocation is complicated by rupture of any of the muscles, care must be taken to suture them before replacing the eyeball.

[3] Panas uses the following solution: biniodide of mercury, 5 cgrams; alcohol 90 per cent, 16 grams; water, 1 litre.

determine the state of vision and the tension of the globe; do not unduly prolong the examination, which speedily becomes harmful, and from which at this stage no special indications can be obtained.

Whether one of the little operations which we shall study immediately be undertaken, or whether the ocular wound requires nothing more than careful cleansing, be careful always to finish by applying an aseptic protecting dressing to the eye. This protective covering is of the greatest importance.

Apply some small oval pieces of sterilized gauze over the closed eye, dry if there is no reaction, but moist if the eye is red, irritated, or painful; over the gauze lay a couple of larger circles of cotton-wool, and fix the dressing with a few turns of a muslin or flannel bandage; do not apply the bandage too tightly, and to avoid undue pressure on the cornea, lay a small roll of gauze at the inner angle of the orbit along the nose under the layer of wool. Lastly, remember that the eye can only be kept at rest by putting the patient to bed and forbidding him to move or talk.

In cases of subconjunctival ruptures and any purely intra-ocular derangement, the immediate treatment is limited to the application of this protective dressing. Different treatment is, however, necessary in cases of total rupture and open wounds.

Wounds of the Cornea.—Let us imagine first of all *a simple wound of the cornea*, a perforation with the point of a sewing needle, scissors, or a knife, or from the thrust of a pen,[1] etc.: a straight cut, of varying length, sometimes dividing the membrane in two; an irregular tear, V-shaped, or stellate, caused by a splinter of glass. The membrane is relaxed and the anterior chamber empty, but there is no protrusion of the iris. Bathe the eye gently and apply the dressing as already described. If the iris and lens are uninjured, a fairly favourable prognosis may be given, taking into consideration the seat of the corneal wound (central or peripheral), its width, the amount of damage to its edges, and the probable degree of interference with vision from the resulting leucoma.

More frequently the iris is prolapsed between the lips of the wound, its pupillary border projecting if the wound is central, its attached margin if the wound is peripheral in the neighbourhood of the sclero-corneal junction: it is necessary in these cases to reduce or destroy the protruded portion.

If but little time has elapsed since the occurrence of the accident, reduction may be attempted. The following case will serve as a type:—

Case 5.—Perforation of the upper part of the cornea, produced some hours previously by a blow with a sharp instrument; protrusion of the iris. A few drops of solution of eserine were introduced, and with a Bowman's probe the iris was replaced. The use of the eserine drops was continued during the following days. At the end of a few days the wound had healed, the pupil was perfectly round, and there was no trace of the accident except for a very small peripheral leucoma (Rochon-Duvignaud).[2]

[1] Such an occurrence is not uncommon amongst school children.

[2] Thèse de Dauran, "De l'intervention précoce dans les plaies du globe oculaire," 1899, p. 48.

Reduction may be effected with the end of a probe or a small spatula. All the manipulations must be conducted with the greatest gentleness, and advantage should be taken of the action of myotics or mydriatics according to the position of the wound.

When the hernia is central, it is necessary to dilate the pupil, so drawing the pupillary border of the iris away from the wound; atropine will therefore be used;[1] do not forget that it increases the intra-ocular tension and becomes dangerous on the appearance of glaucomatous symptoms.

In cases of peripheral prolapse, the myotics, eserine and pilocarpine,[2] which in contracting the pupil spread out the iris, are indicated.

When the hernia is of older standing and adherent, and the prolapsed segment is blackened, lustreless, thickened, shapeless, or again if attempts at reduction have failed, it is best to excise it at once with curved scissors, or to destroy it with a fine point of the thermo-cautery or the red-hot end of a probe.

Wounds of the Sclerotic.—With the exception of some narrow fissures, every wound of the sclerotic should be sutured as soon as possible; immediate closure is the best means of preventing intra-ocular infection. This statement applies equally to simple wounds, affecting the sclerotic alone, to wounds complicated by choroidal protrusion, and to those involving all the tunics of the eye, above all when they have allowed the vitreous to escape.

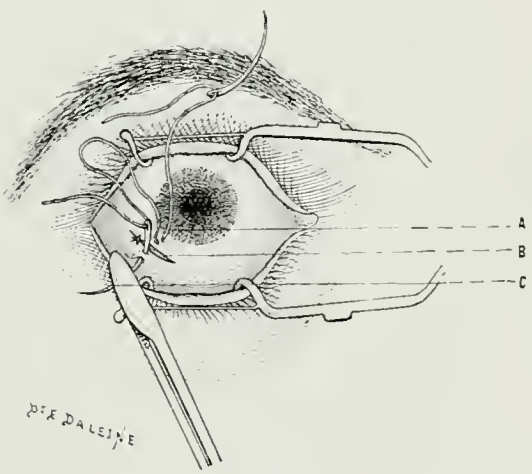


Fig. 121. — Suturing a wound of the sclerotic with two needles. (A) One of the ends of the suture, which has just passed through the conjunctiva and the outer layers of the sclerotic from within outwards. (B) Sclerotic wound; one point of suture already tied. (C) The other needle, also being passed from within outwards.

The suturing is a somewhat delicate task, demanding a good deal of care and some deftness of hand.

Use a fine curved needle, threaded with catgut No. 00 and held with forceps; an ordinary fine sewing needle and fine boiled linen thread will do failing anything else. Strictly speaking, it is the *conjunctiva* rather than the sclerotic that must be sutured; the sutures must not pass through the whole thickness of

[1] One or two drops of a 1 per cent solution: neutral atropine sulphate, 1 part: boiled distilled water 100 parts.

[2] Eserine may be advantageously combined with pilocarpine in the following lotion: pilocarpine nitrate, 10 parts; eserine salicylate, 3 parts; boiled distilled water, 1000 parts. (Terrien, "Conduite à tenir en présence des plaies du globe oculaire," *Presse méd.*, 12 juillet, 1899.)

the sclerotic; they should only pick up the conjunctiva and, if possible, the most external layers of the fibrous tunic. Properly introduced, at right angles to the line of the wound, tightened slowly, these conjunctival sutures are perfectly satisfactory.

When the posterior chamber is opened, the slightest pressure exerted on the edges of the wound may be followed by a fresh escape of the vitreous humour, and the eye thus empties itself more and more. In such a case, therefore, it is sometimes better, instead of using a single needle in the ordinary manner, traversing one lip of the wound from without inwards and the other from within outwards, to use two needles, one on each end of the thread, and pass both ends from within outwards (*Fig.* 121). In this way any pressure on the eyeball is avoided.

Wounds of the Sclero-Corneal Region.—These are serious injuries. Apart even from the often abundant intra-ocular hæmorrhage from the wounded ciliary body, the ciliary protrusions, and the possible dangers of sympathetic ophthalmitis and panophthalmitis, they are badly adapted for suture.

After careful disinfection the conjunctiva will be sutured over the sclerotic segment of the wound, and the eye will be kept closed under a moist dressing; the prognosis must be guarded, and the surgeon be ready to deal with any complications which may appear.

The question of immediate enucleation need only be considered in exceptional cases: even in most serious injuries, the eyeball being perhaps perforated at several points, widely opened and half empty, it is good practice to limit oneself to careful disinfection and the application of a protective dressing. Experience has many times shown that very badly injured eyes may be saved and retain a useful degree of vision. A careful watch will always enable complications to be detected at the outset, and allow time for the performance of any necessary operation.

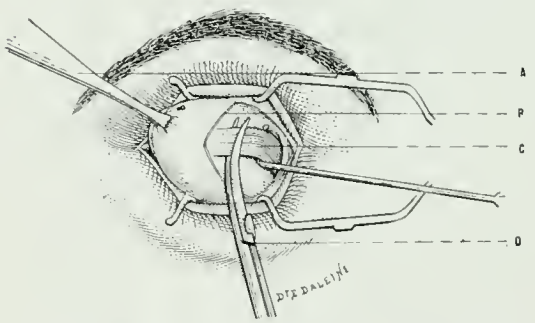


Fig. 122.—Enucleation of the eyeball. First step, dividing the external rectus. (A) Fixation forceps pulling the eyeball inwards. (B) Conjunctival incision. (C) Tendon of the external rectus muscle raised by a hook. (D) Curved scissors slipped under the tendon and ready to divide it.

If more radical measures should be rendered necessary by very extensive injuries and soiling of the wounds, or secondarily by ocular suppuration, one must at least endeavour to obtain the best ultimate prosthetic condition by performing *enucleation*, in the strict sense of the word, within the capsule of Tenon, or by *evisceration*.

Enucleation.—This can be performed with a pair of toothed forceps, fine curved scissors, and a strabismus hook, which may be improvised

with a probe bent at the end. With the dissecting forceps take hold of the conjunctiva, or what remains of the eye, at the middle of the external border of the cornea, and rotate the eyeball inwards. A third of an inch behind the corneal margin, make a small curved incision with the scissors, dividing the conjunctiva and the underlying fascia and exposing the flat, white fasciculated tendon of the external rectus, which the adduction of the eyeball brings into view. Define this tendon and isolate it carefully; raise it up with the hook, slip one point of the scissors below it, and cut it about an eighth of an inch behind the sclerotic attachment (*Fig.* 122). The orbital end retracts; the ocular end, held with the forceps, will serve as a tractor to gradually increase the adduction, while the curved scissors, little by little, and keeping close to the globe, free its postero-external segment. Soon the thick, round, greyish trunk of the optic nerve comes into view; divide it close to the sclerotic (*Fig.* 123).

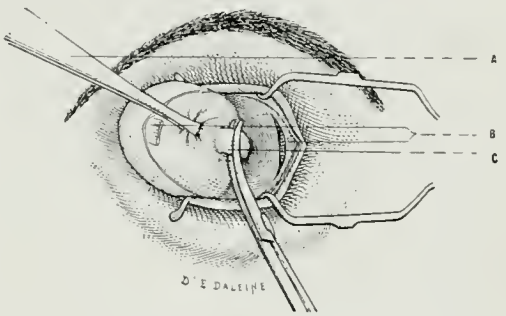


Fig. 123.—Enucleation of the eyeball. Second step, dividing the optic nerve. (A) Fixation forceps. (B) The cut tendon of the external rectus; orbital and ocular ends. (C) Scissors dividing the optic nerve.

The eyeball is now free behind and externally; carry the dissecting forceps to the posterior pole, and, pulling forwards and inwards, dislocate the globe and divide the tendons of the two obliques and the three remaining recti close to their insertions, which are now well exposed (*Fig.* 124). A cut with the scissors divides the conjunctiva on the inner side, and the eye is free.[1] A little pressure quickly checks the bleeding.

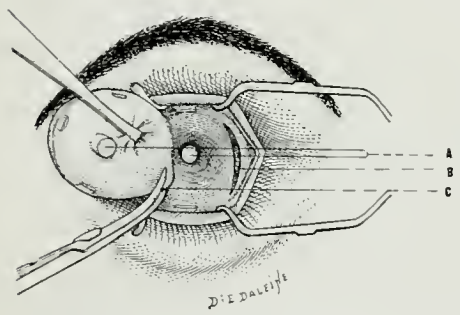


Fig. 124.—Enucleation of the eyeball. Third step, dislocation and removal of the eyeball. (A) Cut optic nerve. (B) External rectus muscle, orbital end. (C) Curved scissors dividing the last attachments.

Evisceration.—Instruments required: Toothed dissecting forceps, Graefe's knife, curved scissors, Volkmann's spoon, suture needles.

Retract the eyelids, incise the conjunctiva all round the cornea, and dissect up a collar about an eighth of an inch wide.

At the base of the collar on the outer side, puncture the sclerotic with Graefe's knife; slip the point of one of the scissor-blades into the opening, and continue the section circularly, detaching the anterior segment of the

[1] Tillaux's method.

eyeball. With the spoon remove the lens and the vitreous humour, and carefully scrape away the choroid and retina, laying bare the deep surface of the sclerotic.

Truc's method of evisceration,[1] in cases of intra-ocular suppuration, is an easy and efficacious plan which requires no special instruments. Retract the lids, fix the eye, and with a Graefe's knife or a narrow bistoury transfix it, from without inwards, a little behind the corneal margin, in the horizontal diameter, and cut out from behind forwards (*Fig.* 125): the anterior segment of the eye is thus divided into two halves; take hold of the flaps one after the other, and detach them with the scissors (*Fig.* 126).

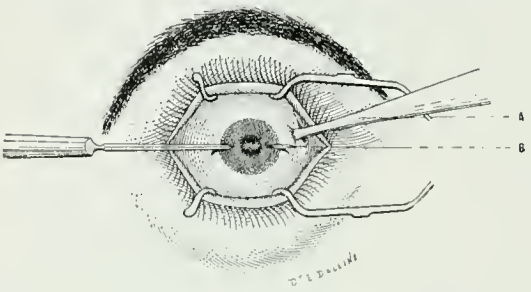


Fig. 125.—Truc's method of emptying the eyeball. First step, transverse division of the cornea. (A) Fixation forceps. (B) Von Graefe's knife, which, after transfixing the anterior chamber, cuts forwards, dividing the cornea into two halves.

The intra-ocular abscess is opened; with the curette, without touching the inner surface of the wall, break up and evacuate the contents. Finish by irrigating the cavity with tepid boiled water, taking care that the cannula does not come in contact with the wall. Leave the stump of the eyeball open, pack it with a small piece of moist sterile gauze, and have it frequently irrigated.

A few words with regard to *paracentesis of the anterior chamber* and *iridectomy*, necessary in some hyperacute cases of glaucoma.

Paracentesis.—We shall mention only two pressing indications for paracentesis: pus in the anterior chamber, whether it follows an infected wound, a burn of the cornea, or is the first expression of panophthalmitis; and some glaucomatous exacerbations, where evacuation of the aqueous humour is of some value, at least as a temporary procedure and to relieve the pain.[2]

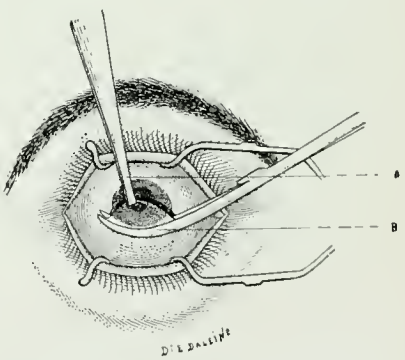


Fig. 126. Truc's method of emptying the eyeball. Second step, excising the two corneal flaps with the curved scissors. (A) Forceps securing the inferior segment. (B) Curved scissors excising the segment.

[1] Truc, "L'évidement dans le traitement de la panophthalmie," *Semaine méd.*, 1894, p. 469.

[2] On one occasion I found myself in such an urgent situation in the country, in the case of a lady affected with chronic glaucoma of the left eye and subject to extremely painful exacerbations. The eye was exceedingly tense and hard, and the suffering atrocious; with a cutting needle, the only instrument I had at hand, I punctured the lower part of the cornea; immediate relief followed the evacuation of the contents of the anterior chamber.

This is an operation which belongs to the common ground of practical surgery, and one which every practitioner should know how to perform.

A Graefe's knife or narrow short bistoury will do; the best instrument is, however, a paracentesis needle (*Fig.* 127). Separate the lids with a retractor, and stand behind the patient, whose head will rest firmly against your chest.

Immediately above the middle of the upper border of the cornea pick up a good fold of the conjunctiva and the subconjunctival tissue with the

Fig. 127.—Paracentesis needle with probe at the other end.

forceps, and fix the eye. Apply the point of the needle to the lower part of the cornea, a little above the margin, and make it enter, gently, slowly, directing it upwards and towards the centre of the eye.

As soon as the needle appears in the anterior chamber, incline the handle backwards, so that the point may not damage the iris but pass up behind the cornea. Introduce the needle till the shoulder comes in contact with the front of the cornea; the fluid is already escaping; withdraw it gently and slowly, keeping the same direction, point forwards.

If a Graefe's knife is used, it is entered, edge downwards, a little within the sclero-corneal junction, and passed across the anterior chamber in front of the iris, to emerge at a symmetrical point; then it is made to cut out and down, forming a very short corneal flap (*Fig.* 128).

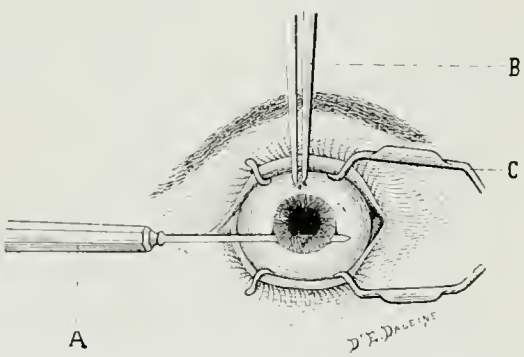


Fig. 128.—Paracentesis of the anterior chamber. (A) Von Graefe's knife transfixing the lower part of the anterior chamber. (B) Fixation forceps. (C) Lid retractor.

If the aqueous humour has preserved its normal fluidity, the chamber empties at once and the cornea relaxes; in a case of hypopyon the thick pus flows badly, and it may be necessary to introduce a small curette through the opening or to inject a little tepid boiled water or tepid 1–4000 solution of sublimate.

Iridectomy.—Without going into any analysis or discussion of the clinical varieties of glaucoma, we merely recall the fact that the acute typical form demands *iridectomy* as the sole means of relieving the patient and saving the eye. A man forty-five years of age is attacked suddenly, during the night, with intense pain in the eye. The pain radiates around the orbit to the forehead, and to the whole of the corresponding

side of the head, increases every instant, and in some hours becomes terribly severe. The eye is red, deeply injected, the pupil dilated, the iris lustreless; the eyeball on palpation feels strangely hard—as hard as a stone; vision is becoming more and more dim. What is to be done? First of all introduce a few drops of a 1 per cent solution of eserine, repeat the instillation once or twice, and if the symptoms do not yield, then immediate iridectomy is necessary.

The eye is cocainized and disinfected. Place the lid retractor in position; then, taking hold of a fold of the bulbar conjunctiva with the fixation forceps, introduce the point of the Graefe knife at the sclero-corneal junction 1 mm. above the external end of the transverse diameter of the cornea, carry it across the anterior chamber, and make it emerge at a symmetrical point on the opposite side; now cut upwards, causing the edge of the knife to follow the curve of the corneal margin. Work slowly, in order to restrain the outflow of the aqueous humour. The iris follows the fluid and usually presents itself in the wound; pick it up gently with suitable forceps (*Fig.* 130), and draw it out from the wound, and with the curved scissors (*Fig.* 129) excise the outdrawn portion, *being careful to carry the section right back to the attached margin.* Do not be afraid of removing the iritic tissues freely, and take care that no fringe of the membrane remains entangled between the lips of the corneal wound.

Fig. 129.
Iridectomy scissors.

Fig. 130.
Curved iridectomy forceps.

To give its best results—and they are often marvellous—von Graefe's operation of iridectomy in glaucoma should be large, and above all peripheral; the benefits obtained by it are so great that every practitioner should make a point of learning how to do it, and should be ready to undertake it, at least in cases of absolute necessity.

FOREIGN BODIES IN THE NASAL FOSSÆ.

In ordinary practice the surgeon is rarely called at the time of the accident; the immediate troubles are not severe, and the patient is almost invariably a child, who has in play introduced into his nose a bean, cherry

stone, or perhaps a boot button, and has only admitted his fault when pressed.

After some days it is noticed that one of the nasal passages is blocked: commonly there is a more or less abundant discharge, mucopurulent and sometimes fœtid: the nose is swollen, inflamed at its root *on one side only*, and the swelling extends to the eyelid and corresponding side of the face; in very young children convulsions supervene. This is the stage when the child comes under observation: the possible presence of a foreign body should be thought of. Make careful enquiries, but remain sceptical in spite of denials, and proceed to make a direct examination.

In the adult it is rare to find foreign bodies in the nose, and the accident comes about in a different manner; during an act of vomiting the body is projected upwards from the pharynx, behind the soft palate, into the nose—usually the middle meatus—and impacted there. Exploration is easier in the adult. Elevating the tip of the nose, in a good light, begin by inspecting the anterior orifice; if nothing is to be seen, use the nasal speculum: or again, the posterior nares may perhaps be examined with the finger passed behind the palate after swabbing the back of the pharynx with cocaine. This method of examination is not practicable in children, at least in very young children; if direct visual examination has revealed nothing, the best plan is to have the child's head firmly held, and then seek for the obstacle with a probe passed along the inferior meatus, keeping close to the floor; if it is a hard body, such as a cherry stone, the probe should at once detect it.

Suppose, therefore, that the presence of a foreign body has been demonstrated, or there are good grounds for assuming the fact. How is it to be extracted?

If visible and accessible, the simplest plan is to remove the foreign body with a Kocher's or small polypus forceps, or the curved end of a small probe may be gently insinuated past it, when it can be drawn forward without any risk of driving it farther in.

Félizet[1] has taught us an excellent and harmless manœuvre analogous to one which we shall presently describe when speaking of foreign bodies in the ear, and which has the very great advantage of rendering any instrumentation and all blind attempts at removal unnecessary: **the injection of tepid boiled water by the opposite nostril.** We may use the douche raised to a height of six to twelve feet[2] or more easily a syringe. If the foreign body occupies the left side of the nose, introduce the nozzle of the douche or the syringe, horizontally into the right nostril. The jet of warm water, directed backwards, must at first be slow and gentle, to avoid taking the soft palate by surprise, and above all to give the orifice of the Eustachian tube time to close. The pressure is now increased, and a

[1] Félizet, "Un procédé nouveau de traitement des corps étrangers des fosses nasales chez les enfants," *Bull. de la Soc. de chir.*, 16 nov., 1898, p. 1010.

[2] According to Félizet, with the douche-can at a height of six feet the pressure is equivalent to about one-fifth of an atmosphere, and gives a jet of eight inches from the opposite nostril: at a height of fifteen feet the pressure is equal to nearly half an atmosphere, and gives a jet of two feet.

feeling of resistance is perceived: this resistance suddenly yields, and the offending body is projected from the opposite nostril, followed by a jet of fluid, or perhaps the jet appears alone, and the foreign body is found lying under it close to the nasal orifice, and is easily removed.

The fluid, directed into the free nostril from before backward, is reflected by the posterior wall of the nasopharynx, and sweeps the obstructed nostril from behind forwards.

Always begin with this *forced irrigation*; employ it without undue violence, with a gradually increasing and sufficient pressure, and the cases will be very rare[1] in which either the use of instruments or the following method of "**sweeping**" **the nose from behind forwards** will be called for. For the latter operation a fine elastic bougie is introduced into the obstructed nostril and insinuated past the foreign body to the back of the pharynx; then it is drawn down with the fingers below the soft palate into the mouth; a bit of cotton-wool, tightly compressed, is securely tied with a thread to the end of the bougie, which is then withdrawn by the nose; the cotton-wool follows the bougie and sweeps the nasal fossa from behind forwards, and either pushes the obstacle out of the nose, or at any rate dislodges and mobilizes it. The method is, however, troublesome, especially when dealing with a child, and, as Félizet says, "uncertain, and always painful."

PERSISTENT EPISTAXIS.

We refer only to those **obstinate nasal hæmorrhages** which by their persistence and abundance render immediate local interference necessary. Do not waste time in trying many different plans, sometimes as dangerous as peculiar; the so-called hæmostatic liquids should never be used; the introduction of a swab soaked in a solution of hydrogen peroxide into the bleeding nostril is always useful as a temporary measure; ice-cold or very hot irrigation may also be used in the same way.

Remember that the "epistaxis region" corresponds as a general rule to the *antero-inferior segment of the septum*, accessible and visible by the nostril.

If, therefore, a nasal speculum, a forehead mirror, and a suitable light are at hand—with knowledge how to use them—after a free preliminary lavage with warm water, cleanse the entrance to the nasal fossæ with small swabs held in forceps, and look for the bleeding point; if it is found definitely, then, following Lermoyez's advice,[2] proceed to **cauterize it** with the thermo-cautery, a pencil of silver nitrate, or a crystal of chromic acid.

Usually, however, it is easier and safer to pack the anterior portion of the nasal cavity;[3] but in order to be efficacious the packing must be direct,

[1] Out of 31 cases reported by Félizet, in 26 the foreign body was expelled at once; in the remaining five it was displaced and the extraction easily completed with forceps or the curette.

[2] *Soc. méd. des hôp.*, 30 oct., 1896.

[3] And as a means of curing the vascular lesion, reserve the cauterization till a little later, when, the bleeding having ceased, its point of origin will be easier to find.

deep, and tight, not simply a plug occluding the orifice of the nostril. It is best done by exposing the bleeding zone with the aid of a speculum and reflected light (*Fig.* 131), but even without the light it can be managed quite well.

Take a long and narrow strip of sterilized gauze, and with a slender forceps introduce it through the speculum; carry the end in as far as possible, and wedge it first between the turbinates, then against the septum; plug the anterior nasal cavity just as the vagina is plugged in some cases of hæmorrhage.

The object in view may also be achieved with some fifteen or twenty wads of sterilized wool, each about the size of a pea, strung together on a thread like the tail of a kite, and soaked in a solution of hydrogen peroxide.[1]

Fig. 131.—Plugging the anterior part of the nasal fossa in a case of epistaxis.

This method of direct anterior packing, properly applied, is more effective than the classical double packing, anterior and posterior, and is less dangerous. The latter ought therefore to be abandoned, except for some very exceptional cases of persistent and profuse bleeding of uncertain origin, and in some conditions of extreme urgency, or when the instruments necessary for anterior packing are not available. I have had to adopt it on two occasions only. One of these concerned a recurrent and dangerous hæmorrhage in an old woman during the night; I had

[1] Guisez, "Complications dans un double tamponnement des fosses nasales et traitement rationnel des épistaxis rebelles," *Gaz. des hôp.*, 30 jan., 1900. The tampons may also be soaked in a 5 per cent solution of antipyrin, a 10 per cent solution of cocaine, or in adrenalin solution 1–1000.

neither nasal speculum nor mirror, and the light was most unsatisfactory; the packing was difficult, but it stopped the bleeding. I removed the plug the following evening.[1]

P. Carnot has introduced a very valuable hæmostatic agent, the **5 per cent solution of gelatin.**[2] We shall give a practical account of the method elsewhere (see TRAUMATIC HÆMORRHAGE). Here the best method of application is as follows: The solution of gelatin having been melted in a water bath, an injection into the bleeding nostril is given with a large syringe or an irrigator, very slowly, and directed in such a manner that the solution is diffused over the whole intranasal surface. Usually the bleeding ceases at once; it is well, a few hours later, to freely irrigate the gelatinized nasal fossa with boiled water.[3]

ABSCESSES OF THE SKULL, FACE, MOUTH, AND THROAT.

I. **Abscesses of the Skull and the Face.**—We have already discussed the localized suppurations secondary to fractures and gunshot wounds of the skull; let us simply remember that in such cases the external abscess is not alone, but that there is a second, subcranial and extradural, which must be looked for and opened. It is the same in abscesses associated with acute osteomyelitis of the cranial bones. (See OSTEOMYELITIS).

Regarding abscesses of the soft pericranial tissues, whether they are subcutaneous, subaponeurotic, or subperiosteal, whether they have a lymphangitic origin or develop in an infected hæmatoma, the only indication is for early incision in a dependent position, drainage, and a moist enveloping dressing.

[1] The special instrument, Bellocq's cannula, is by no means indispensable, but if at hand it is undoubtedly useful. It is introduced into the inferior meatus closed, with the concavity downwards, until the extremity comes in contact with the posterior pharyngeal wall: the fixation screw is then released, and the spring when pushed forward appears below the soft palate in the mouth; to the rounded perforated extremity a strong thread is attached to serve as a tractor to pull the posterior nasal plug into position. The manœuvre is quite easily carried out with the aid of a gum-elastic bougie or catheter. Push the flexible rod along the inferior meatus, feel it come in contact with the posterior pharyngeal wall, and continue the movement: the mouth being widely open, the instrument is seen to descend behind the soft palate and show itself at the base of the tongue; get hold of it with two fingers or a pair of forceps and pull it out as far as the teeth. Tie firmly to the end the double traction thread of the posterior nasal plug, and, as before, in withdrawing the sound bring the plug into position. The plugs are made of aseptic gauze, or of cotton-wool enveloped in a layer of muslin: the posterior plug is of oval shape, and should be about 1½ in. long by ¾ in. thick. One is compelled to give precise measurements, based on the average sizes of the posterior openings; practically these dimensions are somewhat variable, and it is necessary to remember that the plug must fit the opening fairly tightly: do not be afraid, therefore, of making it a little large; on the other hand, do not make it too hard; and see that it is secured with a stout thread. When the posterior plug is in place, the anterior orifice is also plugged, then the two traction threads of the first plug are tied in front of the second plug, and the two are thus bound solidly together.

[2] In salt solution 9-1000 and sterilized at 100 C.

[3] Gelatin is, as we shall subsequently have cause to mention, an excellent culture medium; it would therefore be bad practice to plug the nose with gauze saturated with gelatin solution.

It is not uncommon to see, especially on the lateral aspects of the skull, diffuse abscesses, stripping up the hairy scalp to a large extent, or, deeper still, raising up the temporal muscle. Even if fluctuation is slow in appearing, the swelling, œdema, and diffuse redness show the necessity for incising vertically in the temporal fossa, traversing the muscle if necessary, down to the pus. Several intramuscular arterial branches will be encountered, which must be caught and tied.

With regard to the face, in all suppurative conditions the possibility of phlebitis must be kept in mind and guarded against; the danger is particularly serious in cases of furunculosis and anthrax.

A boil on the lip, especially on the upper lip, must always be considered a serious affection, and treated as such, even in its initial and mildest form. Very early incision should be made, or better still, a central puncture with a fine thermocautery point—the best abortive treatment. When dealing with real anthrax, and especially with those diffuse forms complicated by considerable œdema of the face and threatenings of phlebitis, very free opening up, deep, and out to the margins of the swelling, is required at once.[1]

A boil in the external auditory canal, if of less real gravity, presents often enough a most alarming set of symptoms: pain of extreme severity, radiating to the temple, face, or jaw; fever; swelling of the external ear and the canal, which is also obstructed by a thick, dark red, rounded swelling. A prick into this with the point of the knife, or, if it is situated a little way within the canal, a longitudinal incision made with a narrow, probe-pointed bistoury is usually sufficient to cause the disappearance of the symptoms.

In abscesses of the face proper, the great point in opening them is to **avoid the branches of the facial nerve** (*Fig.* 104), and also to make the incision dependent, so that it may be as small as possible.

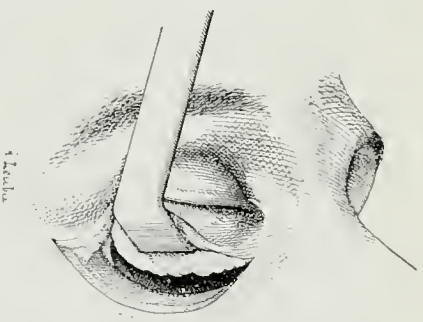


Fig. 132. Sub-orbital incision, to search for and open an orbital abscess.

A few words only with regard to *abscesses of the orbit*, *pre-auricular glandular abscess* and *suppurative parotitis*.

It is most frequently at the level of the orbito-palpebral grooves, below and externally, near the external palpebral angle, or above and within, that an abscess of the orbit tends to point and show itself as a red and œdematous swelling, while the eyeball is more or less displaced to the opposite side, and, above all, pushed forward. Early

[1] Grave complications of phlebitis may be prevented, if taken in time, by resecting the thrombosed facial vein, which can be felt and seen in the groove between the nose and cheek, as a reddened cord; Sébileau has obtained in this manner a brilliant success in a case of furuncle of the upper lip, complicated with facial phlebitis. (*Soc. de chir.*, 6 fév., 1901, p. 123).

incision is necessary if corneal complications, ulcerations and perforations, consecutive to this exophthalmos, are to be avoided; it is made with a narrow bistoury, which is introduced a little within the orbital border at the position of the swelling, and carried from before backwards along the corresponding wall of the orbit; if the abscess is deep, it is better to make a small incision along the orbital border and raise the eye, or to enter from before backwards along the infero-external wall (*Fig.* 132).

A pre-auricular glandular abscess and other collections of pus lying in front of the temporo-maxillary articulation are opened in the following manner: a short vertical incision, limited to the skin, is made at the posterior border of the swelling: a mere puncture with a scalpel, enlarged down to the abscess with a director. After these small incisions, which are quite sufficiently large, the important point is that the small drainage tube should be carried right to the bottom of the cavity with a director or Lister's sinus forceps, and securely fixed there in position.

Similar precautions should be taken in opening an **abscess of the parotid gland** if operation should become necessary.

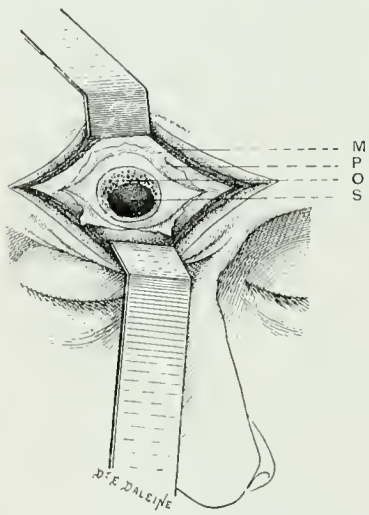


Fig. 133.—Opening the frontal sinus. (M) Frontalis muscle. (P) Periosteum. (O) Opening in the sinus. (S) Cavity of the sinus.

Suppurative parotitis can, however, often be cured by *expression*, when that method is applied from the outset and persistently carried out. With a pad of wool or a gauze compress, pressure movements are made over the whole surface of the gland, working from behind forwards, towards Stenson's duct; the treatment is repeated, if need be, two or three times daily, and under this compressive massage it is usually not long before the pus is seen to escape from the intrabuccal orifice of the canal.

Some forms of parotid suppuration cannot be cured in this manner, perhaps because the treatment has been begun too late, or because the trouble is really an abscess originating in an intraparotid lymphatic gland. In such cases it is always advisable to apply the knife to any prominent œdematous point without waiting for the development of fluctuation; a blunt director alone must be used in the depths of the wound. An incision below and behind is the best when possible.

Usually inflammatory conditions of the **frontal and maxillary sinuses** are of slow development, and rarely necessitate urgent intervention; they may, however, assume acute phlegmonous forms and provoke symptoms demanding immediate action. It is therefore useful to know how to open the frontal sinus and the antrum of Highmore.

To open the *frontal sinus* (*Fig.* 133), make, along the inner third of the

eyebrow, a horizontal or slightly curved incision with the convexity upwards; divide skin, muscle, and periosteum, and define clearly the inner prominence of the superciliary ridge, the boss of the sinus. At this point apply a drill or cut away the bony wall with a small gouge and mallet, making a round opening, which may be enlarged in an outward direction if the cavity of the sinus is very large and irregular, and if the suppuration is very extensive. Then try to pass a small drainage tube into the nose by the inferior opening of the sinus—the infundibulum—and drain in both directions.

The *antrum of Highmore* can be drained through a tooth socket, that of the 1st or 2nd molar for example, the bottom of the alveolus being perforated with a trocar or a small drill after the extraction of the tooth. But it can be opened much more freely through the canine fossa: the upper lip being retracted upwards and outwards, the mucosa is incised horizontally for about an inch at the root of the alveolar process; the thin wall of the sinus is thus exposed at once, and can be perforated easily with a drill or gouge (*Fig.* 134).

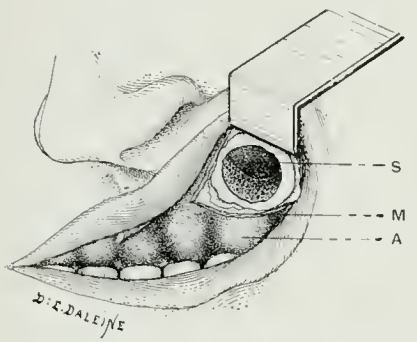


Fig. 134.—Opening the antrum of Highmore by the canine fossa. (A) Sockets of the molar teeth. (M) Mucosa of the gum. (S) Cavity of the opened sinus.

II. **Abscesses of the Mouth and the Throat.**—These sometimes cause serious suffocative symptoms; but even in the absence of obvious pressing symptoms, one ought to make it a general rule to open all abscesses of the mouth or throat at the earliest possible moment.

This rule applies equally to periosteal and tonsillar abscesses, to those of the tongue and the floor of the mouth, as well as to retro- and latero-pharyngeal abscesses.

A few words only with regard to **periosteal abscesses** or gumboils. The diagnosis is usually made with the finger, which detects the elongated swelling—puffy, fluctuant and painful—filling the groove between the jaw and the cheek.

Retract the cheek as far as possible, and into the centre of the swelling plunge the point of the knife, guarded in the way we shall presently describe to within $\frac{3}{4}$ in. of the tip; do not be afraid to go down to the bone and to make a good incision. Around the wisdom tooth, along the ascending ramus of the jaw, the task is sometimes rather difficult: try first to get a good view of, and to illuminate well, the affected area, then make an incision with the point down to the anterior border of the vertical ramus.

Although these little operations occur frequently in ordinary practice, it does not by any means follow that they are well done. Often enough, in some hands, the incision is insufficient, the mucosa is punctured or slit, and the knife is arrested without going down to the pus; the pain persists

and the œdema increases. Remember that on the outer surface of the jaws there is nothing to fear, and that the right procedure is to go boldly to the bottom of the swelling.[1]

Abscesses of the tongue, intramuscular abscesses occupying the mass of the organ, are uncommon. I was called some years ago to see a patient who had been attacked rather suddenly forty-eight hours previously with acute pains in the tongue and in the ear. The swelling had increased very rapidly, and on my arrival the respiratory difficulty was intense, the mouth widely open, there was abundant salivation, and the tongue, greatly swollen, especially at its base, filled all the back of the mouth and prevented any access to the throat. On palpating the tongue with the tip of the finger, a very tender spot was found at the base, and there, under the layer of œdematous submucosa, a sort of central tumefaction, tense and almost hard, was detected ; a cut with a knife gave issue to a considerable quantity of pus, and all the symptoms disappeared.

In such a case, it is on the dorsal surface, at the base, longitudinally, from behind forwards, that the incision must be made, and it should be as deep as is necessary to open the abscess ; on the upper aspect of the tongue hæmorrhage is little to be feared : the important vessels are at the under surface.

Such is the abscess of the base of the tongue, in the vicinity of the epiglottis—often of very threatening character.

In the neighbourhood of the lingual V, other abscesses may be observed, more anteriorily placed or definitely lateral, projecting and readily visible, easy to open, and benign if dealt with early.

Occasionally a *sublingual abscess* may be met with, occupying the floor of the mouth in its posterior zone, lifting up the tongue bodily, and causing the same dangers as an abscess in the posterior part of the tongue. Here, it is no longer against the dorsal surface of the organ that action must be directed ; but below it, in the floor of the mouth, if the mouth can be opened sufficiently and if a definitely fluctuating point can be found ; otherwise it is much better to have recourse to an external, median, suprahyoid incision, penetrating, from below upwards, between the two mylohyoid muscles.

We must not delay in dealing with a typical **tonsillar abscess** :[2] simply remember that a preliminary swabbing with a 5 per cent solution of cocaine is useful ; that, the tongue being well depressed, the incision

[1] Remember that these operations deserve the best care and attention, and that many times a fatal septicæmia has begun in a common gumboil. A case is related by Sébileau and Grandou, in which perimaxillary suppuration, at first confined to the neighbourhood of a carious upper second molar, spread backwards into the pterygo-maxillary and into the temporal fossa, and was followed by a fatal phlebitis of the inferior ophthalmic vein. (*Revue de stomatologie*, mars, 1900, No. 3, p. 103).

[2] Let us point out that the patient is exposed to very serious dangers by awaiting the spontaneous opening of large tonsillar abscesses ; several cases have been published in which death occurred during sleep from asphyxia, the abscess having burst and the pus found its way into the larynx. (*Lancet*, 20 and 27 Sept., 1902).

ought to be made on the antero-internal aspect of the large red swelling, and that it should be fairly long and descend low.

It is convenient to distinguish these cases of suppurative tonsillitis from *peritonsillar abscesses*:[1] most frequently a peritonsillar abscess is *antero-superior*, and forms a red and œdematous swelling, which lifts up the anterior pillar and the adjacent part of the soft palate, and extends as far as the uvula, while the tonsil is pushed downwards and backwards, and more or less hidden from view; incise above and external to the supratonsillar fossa, or, to be more precise, a little outside the intersection of two lines, the one horizontal, passing through the base of the uvula, the other vertical, along the anterior pillar; introduce the bistoury (narrow and guarded in the way to be immediately described) from before backwards and a little from within outwards, and do not be afraid of going to a depth of $\frac{3}{4}$ in. if necessary.

In cases of *posterior peritonsillar abscess* the swelling occupies the posterior pillar and pushes the tonsil forwards: the incision must be made in the centre of the pillar, and in the same direction as before.

Lastly, very rarely one may see the tonsil pushed directly inwards by a thick, puffy, painful swelling continuous with the pharyngeal wall: one has here to deal with an *external peritonsillar abscess*. Early incision is difficult, and may be dangerous, in these cases; it is best to make it across the tonsil, from within outwards, not from before backwards.

With some practice it is possible to open the majority of these peritonsillar abscesses, when well localized, with the grooved director, by way of the supratonsillar fossa, which appears to be their common point of origin. The end of the director, moderately curved, enters above the tonsil, between the two pillars, a little force being necessary: it is made to penetrate upwards and forwards for the anterior abscesses, upwards and backwards for the posterior, and outwards and a little downwards for the external ones: the opening is enlarged when withdrawing the director by a few lateral movements.

We now come to the **retropharyngeal abscess**, which is not uncommon in children, especially in those under three years of age, and which one must know how to look for.

Examine the back of the throat carefully with the eye, and above all with the finger. This is not usually an easy—not always even a safe—proceeding: for laryngeal spasm, and dangerous attacks of apnœa or of syncope, sometimes occur during the course of a simple examination.[2]

The only conclusion to be drawn is that the best means of avoiding such accidents is to work quickly, and in order to do so, *to fix the child securely*.

[1] Always accompanied with trismus. (See Chavasse, "Abcès péri-amygdalien," *Bulletin méd.*, 1904, No. 45, p. 525).

[2] See J. Thoyer-Rozat. "Abcès rétro-pharyngiens idiopathiques des enfants: leur fréquence; leur terminaison par la mort subite." *Thèse de doct.*, 1896, No. 394. Syncope is the accident most frequently seen. If it occurs, if the little patient turns pale and stops breathing, place the child at once with the head low, begin artificial respiration, and continue it persistently. In a case related by Thoyer-Rozat, the apnœa lasted for twelve minutes, but the patient came round and recovered.

Therefore, if an assistant is present, he will wrap the little patient in a blanket, and holding him seated on his knees, will present the child's head, firmly fixed against his own chest, with the face to the light, towards the operator. Depress the jaw and tongue with a spoon, and right at the bottom the pharyngeal swelling will be seen, red, projecting, and median, although somewhat asymmetrical. Apply the tip of the index finger to the summit of the swelling, depress it, and sharply relax the pressure; usually one may detect very definitely a sensation of reflux, a return wave, ballottement, which is quite characteristic.

It is the finger indeed which provides the best, often the only, information. Seat the child on your left knee, with its legs hanging between and fixed by your own; encircle its head firmly with your left forearm, and with the left hand press the cheek in between the upper and lower rows of teeth, to open the mouth and keep it open; slip the right index finger along the back of the tongue to the pharynx; rapid palpation will allow the fluctuating swelling to be felt, and the ballottement obtained of which we have just spoken. Do not forget that some abscesses are situated very low down, and can only be reached by curving the finger below the level of the base of the tongue; make sure that the swelling, without being exactly median, nevertheless occupies the posterior wall, the vertebral aspect of the pharynx, and that it is not lateral.

A retropharyngeal abscess should be opened as soon as it is recognized. Do not trust to emetics or any other indirect method of treatment; do not put off till to-morrow: it has repeatedly happened that on the morrow the patient was dead.[1]

Open the abscess by the mouth except in certain special conditions which we shall mention presently.

Here again the important thing is to have the child securely fixed.[2] Sometimes, by depressing the tongue, it may be possible to see where to make the incision; more often, however, the abscess must be opened "on the finger" as a guide.

The jaws being well separated, carry the left index finger to the back of the throat, pressing down the tongue, and with its tip resting in contact with the fluctuating point; along this finger as a conductor the knife is carried (*Fig.* 135), a narrow, sharp-pointed bistoury, with the blade sheathed up to $\frac{1}{2}$ inch from the tip, by twisting around it a strip of tissue paper, court-plaster, moistened linen, or the classical diachylon plaster. Make the puncture boldly with a sharp stab, and prolong the opening upwards for a distance of at least three-quarters of an inch. The puncture and the incision can be made in an instant if the left index finger has been properly

[1] See some cases mentioned in a paper by Marfan, "L'Abcès chaud rétro-pharyngien," *Bulletin médical*, 27 déc., 1890.

[2] In the same manner as already indicated for the examination; one may also—although the position is often much less convenient for the operator—have the child lying across the knees of an assistant or on a table in a partly inverted position, at an inclination of about three-quarters of a right angle with the horizontal plane. As soon as the abscess is opened the inversion is completed, and the pus escapes directly without any danger of penetrating the air passages.

placed; remember that it is necessary to make the incision as close as possible to the middle line, from below upwards; with these precautions it can be made without fear.

Immediately turn the child's head downwards and forwards, so that the stream of pus may escape freely from the mouth. The thing to be feared, however, is not so much the entry of pus into the air-passages, as laryngeal spasm or syncope, to the risks of which, I again repeat, a slow hesitating performance of the operation exposes the patient.

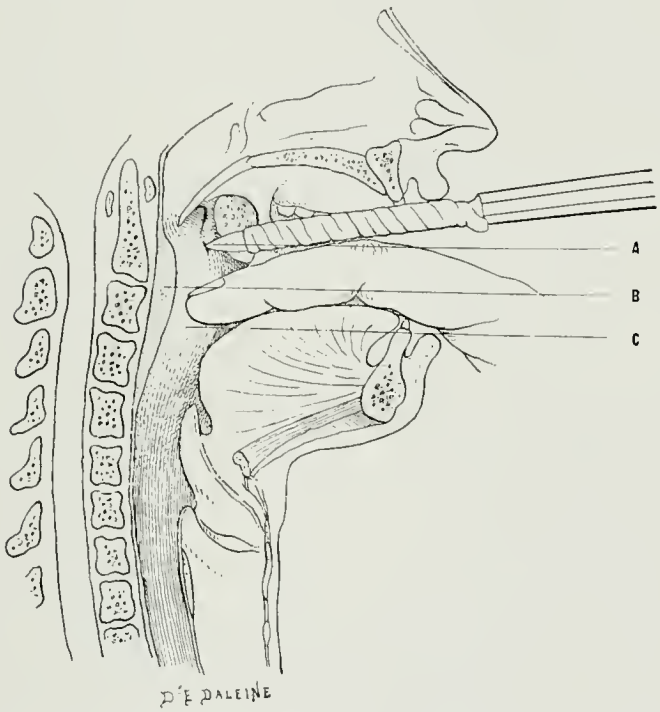


Fig. 135.—Opening a retropharyngeal abscess by the mouth. (A) Straight guarded bistoury puncturing the abscess. (B) The retropharyngeal accumulation of pus. (C) Summit of the abscess marked by the finger.

As soon as the child has recovered its breath, the emptying of the abscess can be completed by a little gentle pressure.

That is the natural and simple method, which certainly requires some practice, but which is applicable in the great majority of the cases.

It is necessary here to consider certain special difficulties and mention some forms of peripharyngeal abscess which will occasionally necessitate the choice of another route.

(*a*). **Trismus may prevent the mouth being opened sufficiently.** One can see nothing or nothing definitely, and the finger cannot be introduced. Endeavour to enlarge the gap between the jaws, with

the assistance of a wooden wedge and a small spoon placed on edge; if one gets a little movement at the back part of the dental arches and can depress the base of the tongue well, sometimes sufficient room may be secured for the passage of the narrow blade of the knife. Nevertheless, it is necessary that the abscess should be very large and very definite in order to work safely by the buccal route under such circumstances.

If it is quite impossible to open the mouth sufficiently, we are driven to the cervical route, which we shall study presently; this is *the exceptional route*, never the operation of choice, in acute retropharyngeal abscesses.

(*b*). When dealing with an abscess situated **low down**, it is very often possible, by attacking its upper part behind the base of the strongly depressed tongue, to open it with the knife by way of the mouth. Then, by pressure with the index finger, empty it from below upwards. But avoid any blind guesswork attempts at opening the abscess with a curved trocar without seeing or feeling anything. Again it is much better to follow the external route.

(*c*). In some cases the external route is indicated by the nature of a **cervical extension** of the abscess.[1]

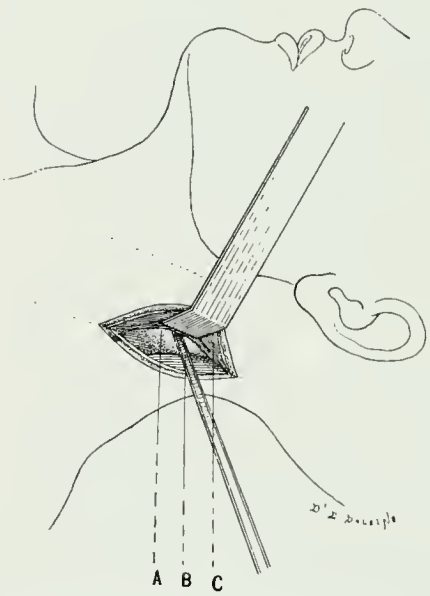


Fig. 136.—Opening a retropharyngeal abscess by external cervical incision. (A) Prominence caused by the abscess. (B) Director opening a track down to the collection of pus. (C) Posterior border of the sternomastoid retracted with the underlying great vessels.

Case 6.—A lad eighteen years of age was sent to me from the medical side, with a large retropharyngeal abscess and urgent symptoms of dyspnœa: there were crowing respiration, congestion of the face, feeble pulse, etc. On the posterior wall of the pharynx the abscess showed as a rounded, very prominent swelling, but on the right side of the neck, along the posterior border of the sternomastoid, there was another swelling, elongated, and enlarging whenever the patient attempted to swallow or to cough; fluctuation, deep but quite definite, could be transmitted from the pharynx to the cervical extension.

I made an incision 1½ in. long, over the posterior border of the sternomastoid, at the height of its lower third, and after having drawn the border of the muscle forwards and separated the cellular tissue, I speedily reached the pocket, punctured it, and opened it freely. It contained a large quantity

[1] That is equivalent to saying, in those cases where the cervical prolongation shows itself definitely and superficially behind the sternomastoid; otherwise if, after the incision has been made, it is necessary to search for the abscess, the cervical operation becomes difficult and may be dangerous.

of fluid pus mixed with grumous material, and my finger went into a large retropharyngeal cavity; the anterior surfaces of the bodies of the upper cervical vertebræ were bare and irregular; it was in reality a cold abscess secondarily infected.

The existence of such a cervical extension naturally indicates the route to be followed, and these pharyngo-cervical abscesses being generally very large, an external incision possesses some very decided advantages. Made at the posterior border of the sternomastoid, it allows of a way being readily opened with the director down to the abscess, passing behind the great vessels (*Fig.* 136), which are usually already pushed out of the way and are not seen; it leaves a scarcely visible scar.

(*d*). There is a last type, the **latero-pharyngeal abscess.** Here the prominence no longer occupies the posterior wall, in or quite near to the middle line; the swelling is lateral, it raises one of the tonsils and pushes it inwards, and often is prolonged outwards into the neck to just below the angle of the jaw.

Distrust these lateral abscesses, and do not attempt to incise them without a most careful preliminary examination with the finger. They generally spring from the carotid group of glands; *they push the internal carotid artery inwards*, and sometimes one may be able to feel the pulsation of the vessel in the wall of the pharynx.

Therefore never puncture them by the mouth, except at a spot carefully examined and definitely fluctuating; in any case, if large, they can almost invariably be better treated by external incision. Make the incision along the anterior border of the sternomastoid below the angle of the jaw, and, after getting through the cervical fascial *work forwards, inwards, and upwards* in the direction of the brawny or fluctuating swelling which can be felt in the depths and which will always be the best guide.[1]

FOREIGN BODIES IN THE EAR.

It is necessary to observe two important rules in these cases :—

(1) *Before attempting anything, always make sure of the presence of the foreign body*; and (2) *Use instruments only as a last resort.*

1. A child (it is nearly always a child) is brought in great haste by his mother; in play, he has just introduced into his ear a boot button, a glass bead, a pebble, pea, pin, or some other object.

Before doing anything else, make a careful examination; notwithstanding the most definite statements, it must not be taken for granted that a foreign body is actually present in the ear.

Remember that cases have occurred in which, during the course of blind attempts at extraction without adequate preliminary exploration, the tympanic membrane has been ruptured, the ossicles have been broken,

[1] See later, ABSCESS OF THE NECK.

and fatal injuries produced. A little girl of five and a half had introduced, so it was said, a bead into one of her ears: for half an hour a doctor groped for it at random; he extracted nothing but particles of bone; bleeding was caused: at the end of an hour and a half the child was dead. At the autopsy *no foreign body was discovered.*[1] Therefore, first make a careful ocular examination, and leave the probe alone; if it must be used subsequently, let it be with the greatest caution.

The ear should be exposed in a good light; with the left thumb and index finger gripping the postero-superior border of the pinna, draw it strongly upwards and backwards, while the right thumb retracts the tragus; the canal, being straightened by this manœuvre, is lighted up. If nothing appears, or nothing definite, the foreign body may be deep, in contact with the tympanum, or perhaps in the middle ear.[2] Now take the otoscope (an instrument which ought to be in the possession of every practitioner) (*Fig.* 137), and introduce it gently into the canal, which is kept straight by traction on the pinna (*Fig.* 138); to light it, use the forehead mirror.

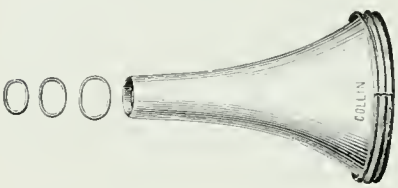


Fig. 137.—Toynbee's ear speculum.

The offending body is now discovered; it is close to the tympanum, blackened, coated with wax; the tympanic membrane is intact. That is well; make no further investigation either with probe or forceps. There is a simple, harmless method which one may rest assured will accomplish its removal: **forcible injections into the ear.**[3] Lukewarm boiled water is all that is necessary; if a powerful injection syringe is at hand, nothing is better; but an ordinary syringe of several ounces capacity answers perfectly well. The jet of fluid must not be directed along the axis of the canal, as it would simply come straight back; it is *the postero-superior wall that must be aimed at*; striking there, the column of liquid spreads out, sweeps over the tympanum and the bottom of the external ear, and is reflected back as a reverse current. Sufficient force should be

[1] Poulet, "Traité des corps étrangers en chirurgie," p. 705.—Another case, reported by Moos, of a splinter of stone supposed to be in the ear of an adult, a man of forty-one years: two medical men made repeated attempts to remove the foreign body: as a result of the forcible manipulations, facial paralysis followed, repeated bleedings, pyæmia, and death. At the autopsy no splinter of stone was found, but terrible injuries to the middle and internal ear, a hole in the floor of the tympanic cavity laid bare the jugular vein, the wall of which was infiltrated with pus. *Arch. f. Augen- und Ohrenheilkunde*, Bd. vii.

[2] Foreign bodies do not penetrate directly into the middle ear: they are pushed into the cavity in attempts at extraction.

[3] This is particularly the method of choice in dealing with accumulations of wax, which sometimes produce sudden, acute, and decidedly alarming symptoms. I remember the case of a gentleman, who although of a very sober temperament, came to me one day in a state of extraordinary excitement: since the morning he had been deaf in one ear, there was a continual buzzing noise and shooting pain all over the head, he was giddy, he was going mad, etc.: four large syringefuls of boiled water calmed all his fears by expelling a black hard concretion as large as a pea.

Raymondeau has reported a case of a soldier who was suddenly attacked by epileptiform convulsions: both ears were found to be obstructed by masses of wax which, after being softened by the introduction of a few drops of glycerin were removed by syringing. (Raymondeau, *Arch. gén. de méd.*, sept., 1882.)

employed; there is nothing that can be damaged on the posterior wall. If nothing has appeared after three or four syringefuls, still persevere, provided the patient is not too tired or dazed by the pressure in the ear. But in any case when we have to do with a quite recent foreign body, there is no urgency, and if the first syringing does not succeed, further attempts may be deferred with an easy mind till the evening or the next day: do not make immediate extraction a necessity, the cost of which may have to be borne by the patient's ear.

Undoubtedly, if the offending body is unmistakably seen and accessible at the bottom of the canal, and there is at hand a suitable pair of forceps, an endeavour may be made to remove it, never working

Fig. 138.—Using the ear speculum.

by guess, but by sight, direct or with the otoscope. We shall describe presently the various plans which may be adopted. But even in the adult such instrumental extraction ought to be considered an exceptional method.

If the injections have failed at the first sitting, the wisest plan is to introduce a few drops of glycerin or warm oil into the canal, to plug it lightly with a small piece of cotton-wool, and to advise the patient to sleep on the affected side: a second or a third attempt will succeed, and always, notwithstanding the delay, with less cost and less irritation of the ear.[1]

[1] If it is an insect or a sharp body, then extraction becomes urgent. Living foreign bodies (beetles cockroaches, larvæ, etc.) ought to be killed before being extracted; for that purpose the best plan is to fill the ear with olive oil, after which an injection of warm water removes the dead bodies.

2.—Unfortunately, we very often see ears which have been badly treated.[1] The accident **had occurred several days previously**; awkward and forcible attempts at extraction have been repeatedly made with hairpins, toothpicks, corkscrews, and so on, and also with the various instruments of a pocket case. There is a purulent discharge from the ear; the canal is ulcerated and bleeding; its swollen walls shut in the foreign body, which sometimes has been pushed through the ruptured membrane into the middle ear, perhaps into the upper part of the middle ear or the attic.

Before any investigation, it is necessary to treat the inflammatory condition, to render the ear less painful and more tolerant. Gentle injections of warm boiled water[2] are employed with this object; these may sometimes be followed by the expulsion of the offending body, even though made only with the intention of cleansing the ear. If no complications are threatening, and if the otitis is severe, it will be good practice to continue this preliminary treatment for some days.

Then an examination should be made with the speculum. The results of this examination are generally much less definite than in the recent cases. The foreign body is half buried in the swollen wall of the canal, surrounded or covered by granulations; if it occupies the middle ear, it may be more or less masked by the ossicles or hidden in the attic. A blunt probe passed in through the speculum often gives useful information; if used blindly, however, it is practically useless, because the sensation felt when the probe comes in contact with a fragment of bone or a denuded bony surface cannot be distinguished from that imparted by a foreign body.

Here again, large injections should first be tried. If they fail and the situation becomes urgent (pain, sleeplessness, serious otitis media), then **direct extraction** becomes necessary. This is not a matter of special instruments; the best tools will do harm if one does not see what one is doing. Therefore it is necessary to understand the use of the otoscope,[3] how to place and light it properly, and how to fix the patient's head securely. A general anæsthetic will often be needed in the adult, always in the child.

Do not try to seize the foreign body transversely with a forceps, and to bring it away by traction. Distrust the forceps; they open badly in the canal, and are apt to catch against and push the object further in. First of all dislodge the foreign body, free it, loosen it—that is the important step,—and then extract it.

A blunt hook bent at a right angle, or a fine probe curved or bent at an angle, are the most useful instruments. Notice if there is not at some point in the circumference of the canal a little space between its wall and the foreign body, allowing sufficient room to slip the bent hook on the flat past the obstacle; if successful, then rotate the point of the hook towards

[1] Nine times out of ten (Politzer).

[2] Hydrogen peroxide solution is also to be recommended.

[3] And above all not to undertake lightly and without sufficient preparation a complicated and dangerous procedure, which, improperly performed, may be fatal.

the centre of the canal, at the same time raise the handle strongly so as to bring the hooked end well round the foreign body, and now draw gently, without jerking, towards the outlet of the canal. Do not expect always to extract it at the first attempt; if the foreign body has been displaced and brought out a little way, a great deal has been accomplished, and it is well to endeavour to complete the task by another large injection, thus reducing to a minimum the amount of instrumentation within the ear.

If the obstruction appears to be complete, try to insinuate the hook past the obstruction, always on the flat, along the lower and anterior part of the wall of the canal,[1] where the least risk is run of injuring the membrane, but do not persist unduly in the attempt.

In cases where the foreign body completely occludes the canal, the methods of attack naturally vary greatly according to the nature of the object: an ordinary pin sharply bent close to the point, and, held in the jaws of a pair of pressure-forceps, may serve to hook a soft body. A fine hook may be inserted into the eyelet of a boot button. If the hole in a glass bead is visible, a method mentioned by Lermoyez [2] may be used: a very fine laminaria tent being introduced into the hole, some warm water is poured into the ear; in a quarter of an hour the tent will have swelled sufficiently to serve as a tractor.

At other times, in dealing, for instance, with the classic bit of pencil, the end of a probe is coated with a gum or glue, placed in contact with the foreign body, allowed to set, and then withdrawn.

3.—Lastly, in the case of **a foreign body of old standing and deeply placed,** associated with unfavourable symptoms, instead of making blind and dangerous attempts at removal by way of the canal, it is preferable at once to turn the ear forward and **open the meatus from behind**; this is a simple, harmless operation, which leaves only an invisible cicatrix. It dates from Paul of Ægina. The indications for it are undoubtedly rare; they depend on, first, *the impossibility or extreme difficulty of extraction by the natural passages*, due to the size, shape, depth, and impaction of the foreign body, and confirmed by the failure of methodical attempts; second, *certain existing or impending complications:* otitis media with mastoid pain, shivers, fever, delirium, intolerable pain, convulsions, repeated hæmorrhages. It is particularly applicable in the case of *foreign bodies in the middle ear.*

The operation is performed in the following manner, always under general anæsthesia: The patient is turned on to the opposite side, the region prepared in the usual way, and the ear again syringed out with warm boiled water. The auricle being held well forwards, make a slightly curved incision[3]—one inch long in a child, two inches in an adult—in the

[1] A plan recommended by Després. A long pin with the point blunted and bent into a hook may be used.

[2] Lermoyez, "Extraction des corps étrangers du conduit auditif," *Presse médicale*, 10 nov., 1900. no. 93. p. 328.

[3] Tröltsch has proposed to make the incision in the supra-auricular groove and to turn the auricle directly downwards. The posterior route gives more room, however.

retro-auricular groove: when the skin is retracted the membranous wall of the canal comes into sight; isolate this with a little dissection, then strip it up from the bony wall, behind, above, and below, as far as possible,[1] *right down to the tympanic membrane* (*Fig.* 139); then cut it across, and, introducing a retractor into the opening, dislocate and pull the whole ear forwards. If still more room is required, part of the posterior wall of the bony canal may be cut away with the gouge; when the foreign body is buried in the upper part of the tympanic cavity, the channel is enlarged upwards and backwards at the expense of the wall of the attic.[2] In either case, if the bone is cut away in thin scales, directed obliquely towards the axis of the canal, no risk is incurred. Extraction then becomes easy as a general rule. The operation is completed, if necessary, by clearing the middle ear of any débris of the ossicles, clots, or purulent matter which it may contain; a strip of sterile gauze is placed in the cavity, and its end brought out by the auditory canal; then the auricle is replaced and carefully sutured in position.[3]

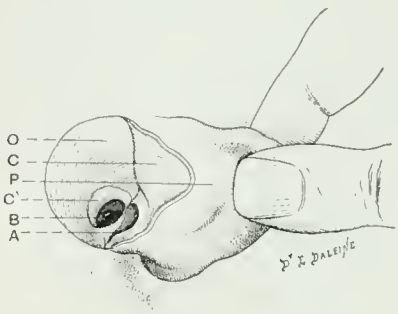


Fig. 139.—Extraction of a foreign body from the ear by a retro-auricular incision: displacement of the auricle. (O) Squamous portion of the temporal bone. (C) Concha. (P) Auricle displaced forwards. (C') Membranous canal. (B) Foreign body (boot-button) in the middle ear. (A) Cut edge of the membranous canal.

If it were made an absolute rule that no attempt should ever be made to extract a recently introduced foreign body from the ear with an instrument, unless carefully-given and frequently-repeated injections had previously failed, we should scarcely ever see a foreign body in the middle ear, and never see serious symptoms, while the operation we have just described—valuable though it is in certain cases—would practically never be required.

OTITIS MEDIA AND MASTOID SUPPURATION.

Acute Suppurative Otitis Media.—Without entering upon an extended discussion of the treatment of acute middle-ear disease, we consider it necessary to mention a simple procedure which is adopted too seldom, and which may result in great benefit at very little cost—we refer to

[1] Particularly if the foreign body is deep.

[2] Stacke's operation in fact.—See, in Broca's article ("Opérations sur l'apophyse mastoïde," *Comptes rendus du Congrès de chirurgie*, 1894, p. 293) a case of this kind.

[3] Richard Pütz ("Ueber operative Entfernung von Fremdkörpern aus dem Ohre," *Diss. Halle*, 1893) collected twenty-three cases of this operation with one death (meningitis secondary to a purulent otitis media of the opposite ear, six weeks after the operation). — Lermoyez recommends splitting the membranous wall of the canal longitudinally before returning it to its place, to prevent the possibility of subsequent contraction of the passage.

paracentesis of the tympanum, practised in these acute and extremely painful forms of suppuration.

The distended, yellowish tympanic membrane bulges outwards, and by puncturing it, the occurrence of a larger and irregular perforation is prevented, while at the same time the further development of the local pathological conditions is arrested, to a certain extent at least, and the intense pain relieved.

After a preliminary irrigation with lukewarm boiled water, gently introduce the aural speculum into the canal, get it into good position, and do not attempt to do anything until the membrane is well illuminated and clearly seen. Often it presents at one point a definite swelling; there the puncture should be made. Usually the membrane is opened in the postero-inferior quadrant —in other words, below and behind the handle of the malleus, which is seen as a vertical white band if the illumination is satisfactory (*Fig.* 140). A sharp-pointed tenotomy knife, a Graefe's knife, or a cataract needle will serve the purpose, if the point is sharp. Make the puncture at the selected spot; a large drop of yellow pus escapes from the opening; do not be content, however, with a simple puncture, but in withdrawing the knife enlarge the opening, making the incision about an eighth of an inch in length. Irrigation with warm water, followed by light packing of the canal with a strip of sterile gauze, completes the little operation.

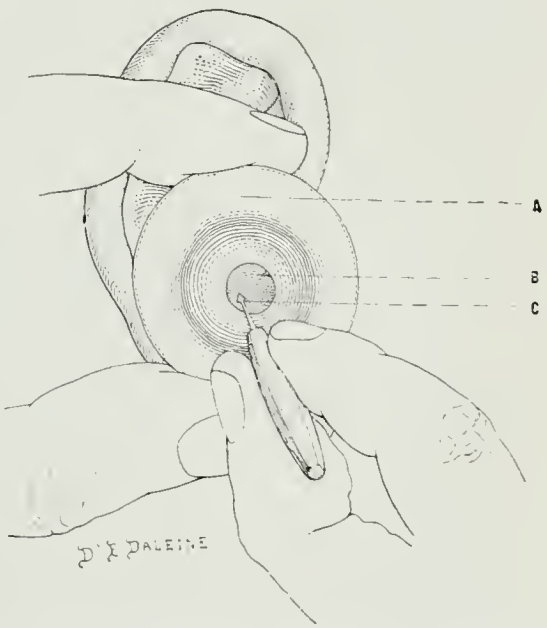


Fig. 140.—Paracentesis of the tympanum. (A) Speculum. (B) Handle of the malleus. (C) Puncture of the tympanic membrane below and behind the handle of the malleus.

Periosteal Otitis (superficial mastoid abscess).—This is the least serious form of intra-aural suppuration, notwithstanding its frequently threatening appearance, and it is important to be able to distinguish it from the deep mastoid complications and to preserve its benign character by opening the periosteal abscess as soon as possible.

A small, delicate boy, of twelve years, who has had for some months a scanty purulent discharge from the left ear, is suddenly attacked, after a cold, with acute pain, fever, and shivering; soon the entire aural region

is invaded by an œdematous swelling. Three days later, the fever still persists, the pain is continuous, and radiates from the ear all over the head; the auricle is puffy, thick, and reddened, and is pushed forwards by a swelling of similar appearance which raises and obliterates the retro-auricular groove; this swelling fluctuates, its whole surface is extremely tender, and the slightest traction on the external ear causes great pain.

The diffuseness of the swelling and obliteration of the retro-auricular fold indicate a superficial mastoid abscess.

As soon as possible, without waiting for the development of definite fluctuation, without wasting time in the use of counter-irritants or anti-phlogistics, in the face of the triple sign of suppuration—fever, local pain, and œdema—make a vertical incision a quarter of an inch behind the ear, right down to the bone. The collection of pus lies below the periosteum.

There is nothing to fear; the knife will be stopped by the bone, and if the posterior auricular artery should be cut, a little pressure or, if necessary, the application of a pair of artery forceps, will speedily stop the bleeding.

Suppurative Mastoiditis.—Here the urgent need for immediate interference depends on reasons more important than the relief of pain—the imminence of possibly fatal complications, amongst which it will be sufficient to mention abscess of the brain, meningitis, lateral sinus phlebitis, and pyæmia. It is well to emphasize the possibility of these terrible complications, of which daily practice furnishes only too many examples, and to point out the risks which may result from a delay in diagnosis or inadequate treatment.

A young man of twenty-four was attacked, while suffering from influenza, with suppurative otitis media; the acute symptoms had passed off and the discharge had diminished, when suddenly the latter ceased: fever returned, accompanied by shivers, intense pain, persistent and increasing headache, delirium, and vomiting. The patient was found in this alarming condition: the region of the mastoid process was the seat of a red œdematous swelling *which did not extend to the auricle nor obliterate the retro-auricular groove*, but under it deep-seated fluctuation was detected: the posterior wall of the auditory meatus was also red and œdematous; pressure was extremely painful over the whole of the mastoid.

Such conditions allow of no hesitation, since, in addition to the symptoms of the deep lesion, there are also all the physical signs of a peri-mastoid collection of pus.

At other times the condition may be quite as serious, although the local superficial signs are less marked. Over the mastoid is found a slight degree of puffiness which rouses no suspicion of subperiosteal suppuration: the skin is scarcely reddened: but pressure with the finger over the whole of the mastoid, or more often over its anterior portion and tip, elicits an acute pain, always the same and detected at no other point; the fever is high, sometimes irregular. There is undoubtedly deep mastoid suppuration, and immediate operative interference is even more necessary than in the preceding case.

The necessary operation consists in freely opening up the mastoid antrum. To limit one's action to an external incision, even in the event of meeting with a perimastoid accumulation of pus, would be to rest content with a procedure quite as inadequate as a simple periosteal incision would be in a typical case of acute osteomyelitis. Be prepared to do all that may be necessary, and remember that the operation, when performed early, gives most satisfactory results.

What are the dangers in opening the mastoid process? First, and most important, **wounding the lateral sinus**; then penetrating into the cranial cavity, and injury to the facial nerve or the horizontal semicircular canal.

The lateral sinus corresponds to the posterior half of the process, the cranial cavity lies above a horizontal line touching the upper border of the bony meatus; the facial nerve and the semicircular canal are embedded deeply in the lower part of the process. (See *Fig.* 144.)

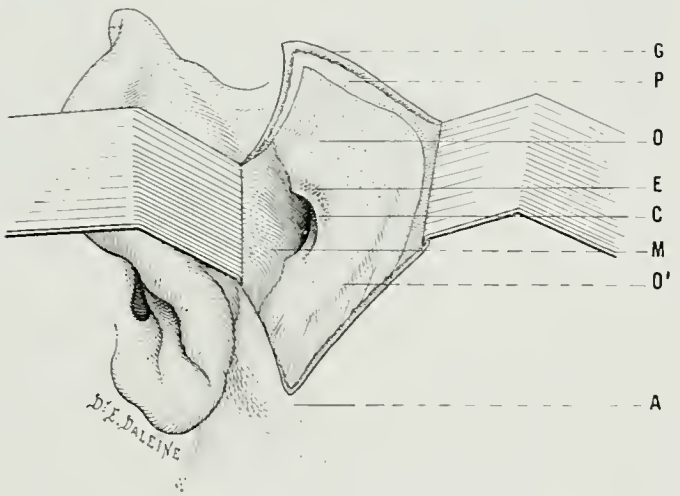


Fig. 141.—The mastoid triangle of election. (G) Retracted skin. (P) Periosteum. (E) Supra-meatal spine. (O) Supra-mastoid crest. (C) Posterior border of the bony auditory canal. (M) Membranous canal drawn forwards. (O') Mastoid crest. (A) Prominence caused by the tip of the mastoid process.

The area where the mastoid is to be opened lies behind the upper half of the posterior border of the bony auditory canal; its position is indicated by a triangle, bounded by three easily recognizable bony landmarks: above, the supramastoid crest, which prolongs the upper border of the zygoma backwards; behind, the mastoid crest; in front, the postero-superior border of the auditory meatus and the suprameatal spine. (*Fig.* 141).

The cranial cavity lies above, the facial nerve below and deep, and the sinus behind. If the opening through the bone is kept parallel to the posterior wall of the auditory canal, it will carry the operator clear of these dangers.

1st step.—**Incision; Exposure of the Mastoid Process.**—Before beginning the operation, make sure of the position; seek for and feel, pressing down through the œdematous overlying tissues, the posterior border of the mastoid process, its point, and its anterior border; follow with the finger the backward prolongation of the zygoma. After this preliminary exploration has been made, the operation area properly prepared and the auricle drawn well forwards, make a slightly curved incision, half an inch behind and parallel to the retro-auricular groove, from the level of the upper border of the auricle above to the tip of the mastoid process below (*Fig.* 142).

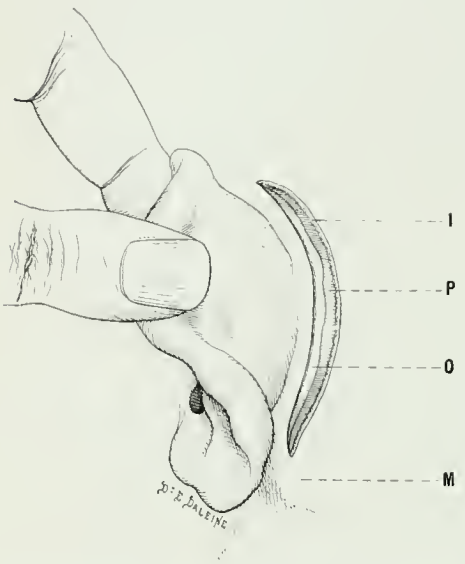


Fig. 142.—Opening the mastoid.—Incision. (I) Skin. (P) Periosteum. (O) Surface of the bone. (M) Prominence caused by the tip of the mastoid process.

Go right down to the bone at once, then apply forceps to the spouting arterioles (posterior auricular). With the elevator strip up the anterior lip of the wound, including the periosteum, forward into the interior of the canal, so that the posterior margin of the bony meatus is clearly exposed; then the suprameatal spine nearly always appears in sight. Strip up the posterior border of the wound, laying bare the whole of the anterior half of the process (*Fig.* 143).

During this first step any periosteal abscess which may be present will have been opened; the pus is wiped away, and the exposed bone, when examined, often presents some rough and reddened area, which indicates where the mastoid should be opened. But if the inflamed area lies outside the triangle of election, if it occupies the apex or the posterior slope of the mastoid, as happens sometimes when extensive sub-periosteal abscesses are present, do not be induced to apply the chisel there; go back to the triangle and define its limits accurately; it is there only that the cancellous bone tissue and the intramastoid focus of suppuration can be opened directly and without danger. A few light strokes with the chisel suffice to remove the small areas affected with superficial osteitis.

This preliminary exposure of the mastoid process ought to be free. The essential condition for a satisfactory and safe operation is to see clearly what is being done. Therefore expose the whole region by retracting the lips of the wound backwards and forwards, when the field will present itself to the eye as definitely as in *Fig.* 141.

2nd step.—**Opening the Mastoid Antrum.**—As a general rule the chisel and mallet are the most suitable instruments. Select a chisel with

a narrow blade and a thick handle;[1] have also at hand a small gouge, which will be found useful when working in the depths of the wound. With a mallet (which may be improvised), a knife, some pairs of pressure-forceps, and a small curette, one has the whole equipment necessary for opening and draining[2] the mastoid. Begin by cutting away the dense outer layer of bone. Around the area of the triangle of election, with four cuts of the chisel, map out a square measuring half an inch, and within that area proceed to remove the bone in thin scales (see *Plate II*), making the superficial

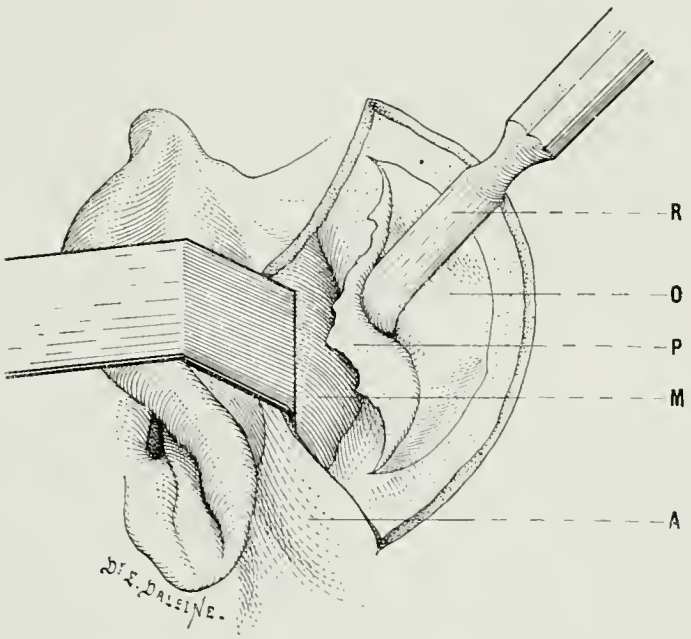


Fig. 143.—Opening the mastoid.—Separation of the periosteum; exposure of the triangle of election. (R) Elevator raising the periosteum. (O) Bony triangle. (P) Periosteum. (M) Membranous wall of the auditory canal. (A) Apex of the mastoid.

scale fairly large (the sinus is still safely distant), thus securing a wide orifice to the shaft which is about to be bored in the bone; it is the only way to see clearly in the deeper layers and to preserve the proper direction.

Continue the operation, *keeping the edge of the chisel directed towards the upper border of the auditory meatus as though intending finally to open into it*; the danger lies either behind (the sinus) on the one hand, or below and in front (the facial nerve) on the other (*Fig.* 144). Continue to work *upwards, inwards, and forwards*, enlarging the funnel scale by scale (*Fig.*

[1] It is a mistake to think that the more delicate surgical operations can only be done with very small instruments, veritable toys, which cannot be properly gripped in the hand and are in consequence badly controlled. With a chisel having a large handle, and a little practice, one has a better mastery of the work and accidents are less to be feared.

[2] That is indeed the essential object of the operation, viz., mastoid drainage.

145), taking care however that these scales are of sufficient area to prevent the cavity degenerating into an irregular fissure.

A narrow chisel or a small gouge is the most convenient instrument for hollowing out the deeper part of the opening. Work inwards for a depth of a third to half an inch; if at this depth the antrum is not reached, and if, after due verification, it is evident that the proper direction has been kept, it will be better to stop; or if dealing with a very large spongy mastoid to continue a little farther, working very cautiously, with the edge of the chisel always directed towards the top of the auditory canal.

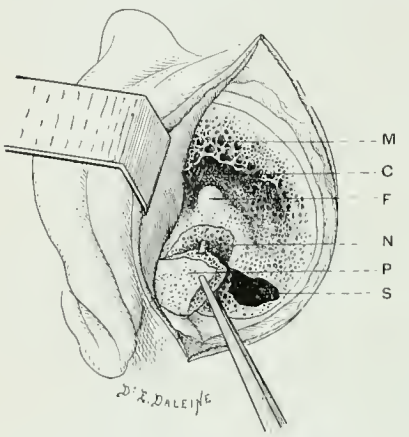


Fig. 144.—Relations of the tympano-mastoid opening to the facial nerve and the lateral sinus. (C) Tympanic cavity, free communication between which and the opening in the mastoid has just been established by removal of the outer wall of the aditus. (F) Spur of the facial nerve. (M) Cancellous tissue at the base of the mastoid. (N) Facial nerve. (P) Apex of the mastoid process detached to show the track of the facial nerve. (S) Lateral sinus, opened.

With a small burr of 7 mm. diameter, the operation can be carried out very simply and speedily. Apply the perforator at the centre of the triangle of election, make the preliminary opening, and then bore cautiously with the burr, keeping the instrument *carefully at right angles to the surface of the bone* (*Fig.* 146); if one has to deal with a definite collection of pus in a mastoid with large cells, the pus will be seen to escape as soon as the compact outer layer of the bone is got through.

It is necessary to be forewarned of different conditions which may be met with in some cases and which influence the subsequent steps of the operation.

A.—In its most simple form the mastoid abscess lies at the surface of the process;[1] as soon as the cortical layer is broken through, the pus escapes.

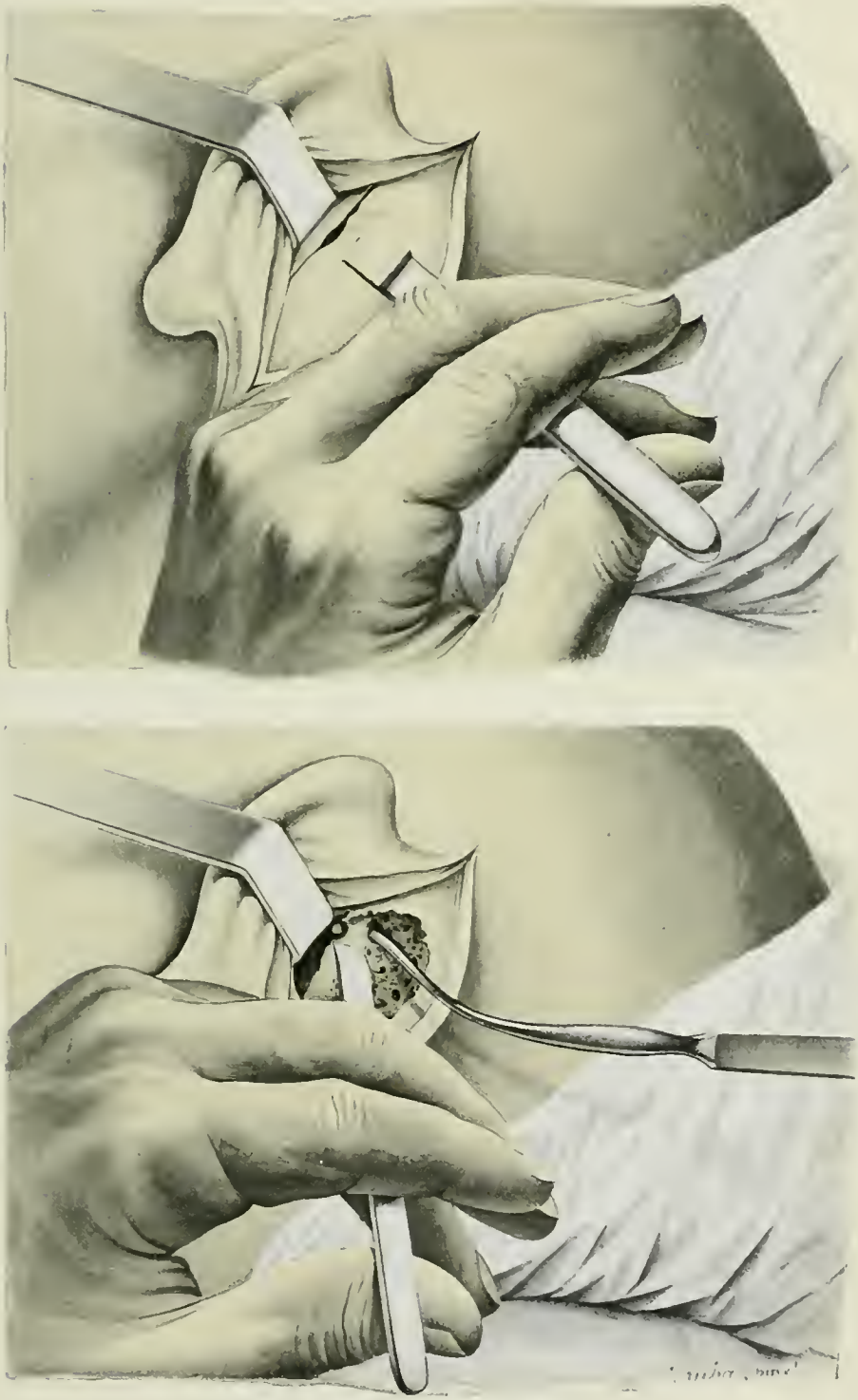
The subsequent procedure ought then to be limited to sufficiently widening the opening just made, and to opening up any secondary cavities with the chisel or sharp spoon handled very carefully.

B.—The operation, however, may not always be so simple; do not forget that as a rule, particularly in the adult, a mastoid abscess is a deep abscess, and that it is necessary sometimes to search for the antrum below a greatly thickened layer of bone.

Again, one must not be misled by the term "abscess," and expect to find a large collection of pus; quite often, after having bored to a depth of half

[1] Particularly in children.

Plate II.—Opening the mastoid.—In the upper figure the first step of the operation is shown. A square scale of the outer compact bony layer has been cut away with the chisel within the area of the triangle of election. In the lower figure the opening in the mastoid has been extended into the middle ear: Stacke's guide has been passed into the aditus, and the outer wall of the attic is about to be cut away with the chisel, which is directed obliquely upwards and inwards.



TREPHINING THE MASTOID

an inch and even more, into the dense tissue of a thickened mastoid, only a few drops of pus may be found. Do not be astonished that there is no more: and if the instructions given above have been followed closely, if the mastoid cells have been properly opened up, and the antrum cleared out, do not be tempted to leave the track just made to conduct a further blind search: curette the wall of the little abscess cavity, drain it, and stop there. An excellent and beneficial operation has been done, for it is a point well worth emphasizing that the value of a mastoid operation is not to be gauged by the quantity of pus evacuated.[1] Once the mastoid abscess has been opened, the best plan, to my mind, is *to drain it with a*

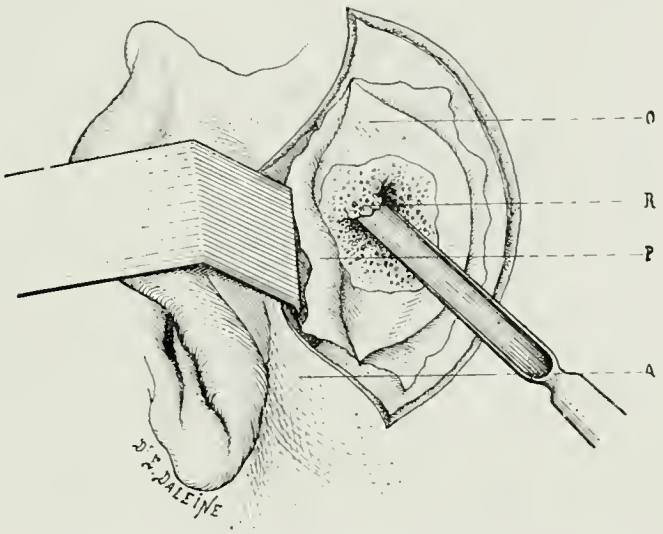


Fig. 145.—Opening the mastoid with the gouge. (O) Bone surface stripped of periosteum. (R) Gouge cutting into the process, from without inwards, from behind forwards, and from below upwards. (P) Periosteum reflected. (A) Apex of the mastoid process.

drainage tube, placed right to the bottom of the antrum and held in position by a little gauze packed around it; the auditory canal should also be lightly packed. The treatment of the external wound should be limited to the introduction of one or two sutures at its extremities.

C.—The bone lesions in the mastoid process and the middle ear are sometimes very deep, and necessitate a much more complicated operation.

Case 7.—A woman, aged 30, was brought suffering from fever and intense pain in the left ear: there were sleeplessness, delirium, and occasional vomiting, and the cerebral condition was alarming. The mastoid region was occupied by

[1] Even in cases where the symptoms have been most characteristic, it may happen that at operation only a somewhat œdematous layer of tissue is found in contact with the mastoid, and in the interior, in the deep cells, nothing but a little reddish-grey tissue, like lees of wine, without any real pus: here again do not persist in trying to open an abscess which does not exist: the opening up of the mastoid will be none the less useful although pus has not been found.

an evidently fluctuating swelling ; further, deep pressure revealed acute tenderness over the whole of the process. Immediate operation : on making the incision and evacuating the perimastoid abscess, I found nearly the whole of the outer wall of the process necrotic, separated into three pieces, which overlapped each other around a central orifice from which some pus was escaping. Using the gouge as a lever, I succeeded in detaching and removing the sequestra, and then discovered that the whole thickness of the mastoid was converted into a mass of broken-down bone tissue mixed with pus. The whole cavity was cleared out with a sharp spoon; in front it extended into the auditory canal; posteriorly, the wall of the sinus was seen, widely exposed but intact. The great cavity filled up quickly, and in two months the patient was completely cured.

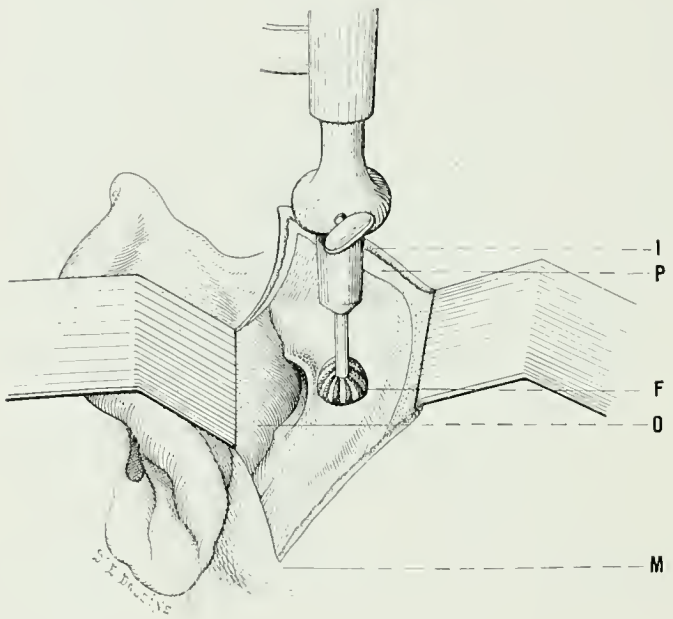


Fig. 146.—Opening the mastoid with the burr. (I) Skin. (P) Periosteum. (F) Burr penetrating into the bone at the point of election. (O) Membranous wall of the canal. (M) Apex of the mastoid process.

In such conditions the operation becomes " atypical," as the Germans say ; prudent action in such a case does not consist in contenting oneself with an incomplete operation, but in making as complete a clearance as possible, while avoiding any rough or violent manipulations, and keeping in sight and avoiding the dangerous areas.

D.—At other times the mastoid is extensively damaged ; but the mastoiditis has been an acute exacerbation of an old and chronic case of middle-ear disease. It is necessary then not simply to open the mastoid abscess, but to open up freely the middle ear and its upper extension, the attic.

In such a case, therefore, make a longer incision, curving forwards at

its upper extremity; with the periosteal elevator free the membranous canal and turn it completely forward out of the bony meatus under a retractor, thus exposing the tympanic cavity. Open the mastoid as before in the area of the triangle of election; at the bottom of the antrum, in its upper, inner, and anterior corner, will be seen *the posterior opening of the passage into the middle ear* (*the aditus*); introduce the end of Stacke's guide (*Fig.* 147) into the orifice, which is then enlarged with the chisel sufficiently to permit of the guide being passed through the whole length of the aditus into the attic. The wedge of bone lying external to the guide, the outer wall of the aditus, must now be removed by two cuts—the upper one parallel to the upper border of the bony meatus, the lower one oblique from below upwards (*Plate II*)—directed to meet obliquely at the guide, which protects the spur of the facial nerve.

After the passage has been laid open, cut away the outer wall of the attic (see *Fig.* 97). In order to do this, first remove the remains of the ossicles with a small curette or fine forceps, then pass the end of Stacke's guide into the cavity, beak upwards, draw the instrument outwards until the beak is felt to come in contact with the inner surface of the wall of the attic, then with a narrow gouge cut away the little bony partition until the roof of the attic is continuous with the upper boundary of the external cavity.

Fig. 147.—Stacke's guide.

It only then remains to complete the evacuation and cleansing of the middle ear by the gentle use of the sharp spoon; it sometimes happens in the conditions under discussion that osteitis and necrosis have already done a considerable part of the work; the antrum and the middle ear communicating freely and containing nothing but diseased tissues. This is an additional reason for careful and gentle manipulations.

If the clearing out of the cavity has been complete, if no doubtful area remains, and there is no suspicion of any intracranial complication, the retro-auricular wound should be closed after having split the membranous canal along the whole length of its posterior wall and returned it to its place; the cavities of the tympanum and antrum are packed with strips of gauze, the ends of which are brought out through the slit in the external meatus, by which route the subsequent dressings will be performed.

If there is any uncertainty, however—a not uncommon state of affairs in the acute suppurative conditions we are considering—it would be dangerous to pack by way of the canal alone; the posterior wound must therefore be left partly open, and the ends of the strips of gauze brought out by both canal and wound.

Should there be no fever, no haste is needed in removing the packing; leaving it in position in suitable cases is much superior to the treatment by frequently repeated daily irrigations, the latter being only indicated by the persistence of fever and pain. On removing packing

which had been left in position for ten or twelve days, I have often seen the walls of very large cavities dry, clean, and covered by healthy red granulations.

We have said that **wounding the lateral sinus** was the principal danger to be avoided in opening the mastoid; as a general rule this is an accident very easily avoided by attention to a few simple and definite details. Nevertheless, the accident may happen; and it has occurred under the most skilful hands. It is always serious, but becomes particularly so if the operator loses his head and thinks that all is lost.

A jet of dark blood floods the wound. Place the finger at once on the bleeding spot, and while the opening in the sinus is thus occluded, cleanse, with gauze swabs, the surrounding area, which is often covered with pus; indeed, if the bleeding is one of the dangers of a wound of the sinus, another, and not the least, is infection—phlebitis and its consequences.

If there is sufficient catgut (several yards are required) it may be used to plug the cavity of the sinus; but the same object can be attained perfectly well with narrow strips of aseptic gauze, introduced into the interior of the sinus with a director and tightly packed above and below the wounded point.

Intracranial Abscess Secondary to Middle-Ear Disease.—These endocranial suppurations, which originate from mastoid and middle-ear disease, are usually situated in the neighbourhood of the petrous bone, on its anterior surface, **temporo-sphenoidal**, or at the posterior surface, **cerebellar**; they may be *extradural* or *intradural*, *pericerebral* or *intracerebral*, single or multiple; they remain for a certain period circumscribed and curable if the treatment appropriate to any abscess can be applied to them, viz., opening and drainage.

The theory is simple, but in this region the practical application is often difficult; still there are some forms of endocranial abscess which can be dealt with perfectly well by any one who is able to perform the mastoid operation.

The following case will serve as a basis for further remarks :—

Case 8.—A healthy man had been attacked with influenza and had to take to bed three weeks before; some days later the right ear began to discharge. No further history could be obtained. We found him dejected, drowsy, with swollen face and heavy eyes; he replied only by monosyllables to our pressing enquiries. "Je suis comateux," he repeated several times, using by chance a word which he had heard pronounced by his bedside. There was no facial paralysis, the pupils were equal, but the limbs of the left side, especially the arm, showed a moderate degree of paralysis.

The auditory meatus was full of pus; over the mastoid process the skin was red and œdematous, and pressure with the finger elicited definite pain, notwithstanding the patient's mental dullness; higher up, over the lower part of the temporal fossa, pressure produced the same pain, indicated by a movement of the face and a complaining groan. The temperature had been about 102°–103° for several days, and the pulse, fairly strong, was rather slow (60 to 61).

Otitis media, suppurative mastoiditis, intracranial abscess—such was the quite evident diagnosis. Operation was performed under chloroform, adminis-

tered very cautiously: a vertical incision, slightly curved forwards at the upper end, was made from the apex of the mastoid up to the level of the upper border of the auricle, its upper extremity involving the temporal muscle; with the elevator the anterior lip of the wound was rapidly reflected, then the posterior lip, in such a manner as to expose the whole mastoid region freely.

I first opened the mastoid by means of the chisel, in the triangle of election, and found an abscess; then extending the opening which had just been made, directly upwards, I cut away the supramastoid crest with the gouge, and enlarging the cranial opening with the gouge-forceps, found the dura mater reddened and with a little pus lying on its surface. On raising the membrane with the end of a director a stream of pus flowed out: the abscess was therefore situated on the anterior surface of the petrous bone, and with the aid of a retractor I was able to detect a perforation in the dura mater, and that in reality I had to do with a *temporo-sphenoidal abscess*. It was cleaned out with gauze, and a drainage tube introduced into the cavity, another tube being placed in the mastoid opening, and the rest of the wound packed.

It will be seen that in the case just described, the diagnosis of intracranial abscess was easily made, as the condition was indicated by undoubted paresis of the limbs on the left side of the body. Such localizing signs are, however, uncommon in cases of cerebral abscess due to middle-ear disease, and their absence would not justify any delay in opening the skull. The *fever* contrasting with the *slow pulse*, the *mental dullness* varied by *occasional delirium*, *the pain* extending over the whole of the side of the head, elicited not only by pressure on the mastoid but also in the *lower temporal region* and sometimes in the occipital area, *the vomiting* and the *pupillary inequality*, supply as a general rule amply sufficient data on which to base a diagnosis of intracranial *suppuration*.[1]

It is generally very difficult to determine the seat of the abscess beforehand, the localization of the pain being often too indefinite to serve as a certain guide. But as a practical point it is to be remembered that *in three cases out of four an intracranial abscess of otitic origin lies on the anterior surface of the petrous bone, and is therefore in the temporo-sphenoidal lobe; in the fourth case only does it lie opposite the posterior surface, in the substance of the cerebellum.* Excluding cases with other definite indications, it is therefore always the area above the petrous bone which should be first exposed and explored. To do this, the method already indicated is the most simple: first **freely open up the antrum, the aditus, and the middle ear, and then enlarge the bony opening in an upward direction** (*Fig.* 148).

During the preliminary removal of bone, fairly often one will find a pus track—a little opening lined with fungous granulations, which, if followed, will lead to the intracranial focus. Therefore, carefully examine the wall of the antrum, its angles and corners, with the eye and the probe; if a drop of pus can be seen escaping and the probe can be introduced into the track, follow it up by enlarging the opening with the chisel, and afterwards with the gouge-forceps.

[1] Lumbar puncture may be an important factor in the diagnosis, when the fluid obtained is turbid, perhaps purulent in appearance, and contains an excess of polynuclear leucocytes.

If the examination is attended by negative results, then direct the attack against the supramastoid crest, just above the antrum, cautiously cut the bone away with chisel and mallet, and as soon as the dura comes into sight, lay aside the chisel and enlarge the breach with the gonge-forceps at the expense of the squamous portion of the temporal bone above, and of the *tegmen tympani et antri* below; do not be afraid of making a large opening.

After the skull is opened, several possibilities may present themselves.

(*a*). It may happen, as in the case already quoted, that *the pus makes its appearance as soon as the skull is opened;* then, by simply raising the dura carefully with the end of a director, one can empty an extradural

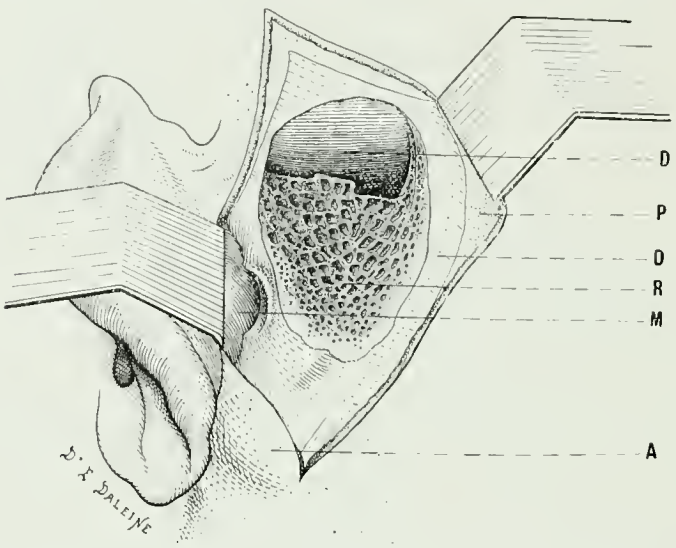


Fig. 148.—Opening the middle cerebral fossa at the base of the mastoid process. (D) Dura-mater. (P) Periosteum. (O) Outer surface of the mastoid. (R) Oblique cut surface of the opening in the mastoid. (M) Membranous wall of the auditory meatus. (A) Apex of the mastoid process.

collection; in other cases, following the stream of pus may lead into a cavity, the opening of which is very readily enlarged by gentle pressure with the director, and the contents evacuated; it is a cerebral abscess in the temporo-sphenoidal lobe.

In either case the further treatment is the same: empty the abscess, whether it is extradural or intracranial, cleanse the walls carefully with very small swabs mounted on holders, examine very cautiously to see if there is a neighbouring pocket of pus, place a drainage tube in the cavity, and pack some gauze loosely around the tube.

(*b*). The conditions found in another case may be different: *the dura-mater appears intact* in the exposed area, and there is no sign of pus.

One must not conclude, however, that pus is really absent without further search. Raise the membrane with the director and separate it gently

forwards and inwards; the abscess does not always extend out as far as the temporal fossa; it is sometimes situated nearer the apex of the petrous bone, and by gradually exposing the upper surface of the bone, from without inwards, one may succeed in finding it.

If there is no pus outside the dura, but the membrane appears tense and is without pulsation, then incise it; if there is an abscess in the temporal lobe, the cerebral surface will be usually found red, friable, and adherent to the dura, and the slightest pressure with the director will open a way into the abscess cavity.

Again, the surface of the brain may present a normal appearance; it is rare, however, in a case of cerebral abscess that there is not some local

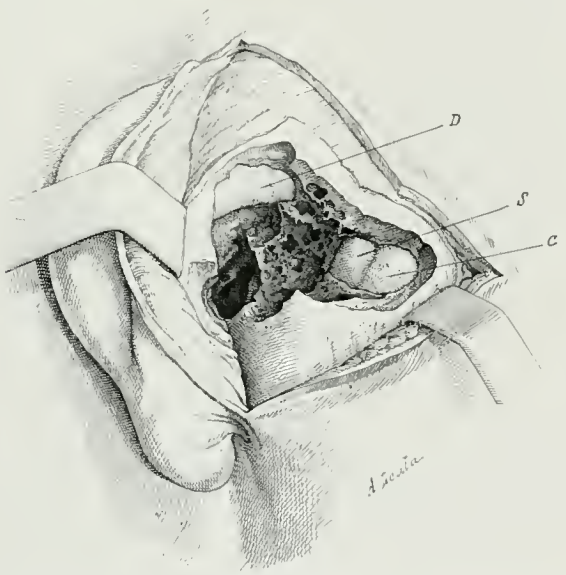


Fig. 149.—Opening the mastoid, with exposure of the temporo-sphenoidal lobe, the lateral sinus, and the cerebellum. (D) Cerebral dura mater. (S) Lateral sinus. (C) Cerebellar dura mater.

swelling or area of increased resistance, some reddening and œdema of the surface, to indicate the underlying condition; if any such sign is discovered, puncture the brain at this spot with a narrow-bladed knife; even if this procedure gives no positive results, it will do no harm if performed with aseptic precautions.

The exploration becomes much more difficult when the abscess is situated at the posterior (the cerebellar) surface of the petrous bone.

Sometimes a guiding perforation may be found in this situation also. If not, after providing abundant room by carrying a horizontal incision backwards from the middle of the retro-auricular wound, enlarge the opening in the mastoid backwards, by very carefully cutting away the posterior portion of the bone; go straight to the sinus and expose it; that

is the best method of protecting it; besides which it is often thrombosed or suppurating. Expose the sinus freely, so that it may be recognized definitely; continue the opening in the bone beyond it with the gouge-forceps, and this will soon give access (*Fig.* 149) to the antero-lateral part of the cerebellar hemisphere.

Here again the suppuration may be either *extradural* or *intradural*, and in the latter case the accumulation of pus may lie directly under the membrane, or one may have to do with an intracerebellar abscess lying at a greater or less depth from the surface. The various exploratory manœuvres already detailed in speaking of temporo-sphenoidal abscess are here equally applicable. If more room is required, the retromastoid opening can be enlarged downwards and backwards with the gouge-forceps.

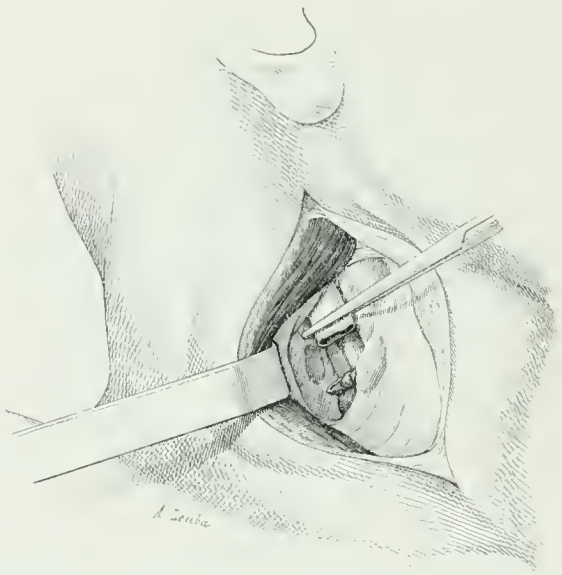


Fig. 150. Operative treatment of thrombosis of the lateral sinus. Ligature of the internal jugular vein in the neck. The lower end of the vein has been ligated, the upper end is still held by the forceps; behind, and internal to the position of the vein, the carotid artery and the vagus nerve are seen, and around the vein several large swollen glands.

Lastly, in the event of **thrombosis of the lateral sinus**, or **suppurative sinusitis**, it is necessary to open, empty, and drain the sinus. The typical procedure required in such cases consists of three principal steps :—

1. Ligature of the internal jugular vein in the neck (*Fig.* 150) at a level varying according to the lower limit of the thrombosis. The vein is exposed under the anterior border of the sternomastoid, the enlarged glands which commonly cover it are separated and removed, then the vessel is carefully isolated from the carotid artery and the vagus nerve, and the level to which the thrombus has descended is determined. Below this point two ligatures are placed and tied around the vein about half an inch apart, and the vessel is divided between them; the upper ligatured

end is brought out at the superior extremity of the wound, the rest of which is then closed.

2. Exposure of the lateral sinus by prolonging the mastoid opening backwards on to the posterior part of the process at the level of the auditory meatus, and, after exposing the sinus, extending the breach from above downwards with the chisel, or the gouge-forceps.

3. Incision of the whole of the exposed outer wall of the sinus (*Fig.* 151), evacuation of the pus and the clots, using a curette if necessary, from the upper end—that is, from the direction of the inion and the torcular Herophili. As soon as the clot has been cleared out a sudden gush of dark blood must be expected; the channel is at once plugged with gauze; the ligature is then removed from the upper end of the jugular vein, which had been brought out through the incision in the neck, and the segment of the vessel above that point irrigated from the mastoid wound with boiled water to wash out any remaining clots. All that then remains to be done is to fix a small drainage tube in the upper cut end of the vein below, another in the lower part of the sinus above, and to pack the rest of the exposed cavity of the sinus.[1]

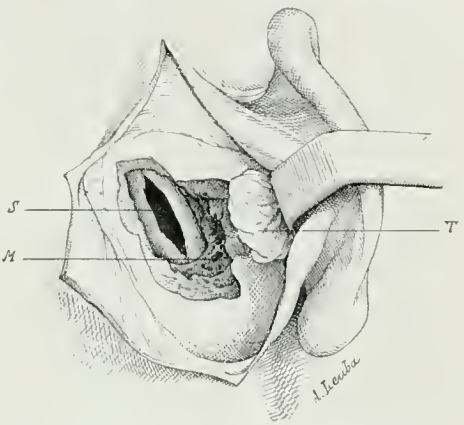


Fig. 151. Operative treatment of thrombosis of the lateral sinus. The opening in the mastoid is enlarged backwards, the sinus exposed and incised. (M) Opening in the mastoid. (S) Lateral sinus incised, exposing the thrombus. (T) Gauze covering the cavity of the middle ear.

[1] With regard to the treatment of suppurative meningitis, perforation of the cranium at various points, opening and draining the subdural space, with free irrigation with sterile saline solution, may be tried; but unfortunately the condition is practically hopeless.

SECTION III. THE NECK.

WOUNDS OF THE NECK.

I.—WOUNDS OF THE GREAT VESSELS. PRIMARY AND SECONDARY HÆMORRHAGE.

Hæmorrhage is always profuse in wounds of the neck, even when it is altogether venous; the blood then runs in a thick continuous stream, gushing perhaps, but never in the great pulsating red jet of carotid hæmorrhage. Compression, properly applied, suffices temporarily to check the bleeding.

A woman aged thirty years had received two stabs with a long knife in the left cervical region; she was picked up covered with blood; the spectators said that she had lost over a quart of blood. We saw her two hours later; a large compressive dressing surrounded the neck; she was blanched, the extremities cold, the voice faint, the pulse very feeble and extremely rapid. She had spat up and vomited some blood, and there was the question of a possible wound of the œsophagus and internal hæmorrhage. She rallied after repeated saline infusion. The dressing was removed; one of the wounds affected the lower part of the parotid region; the other, a flap wound, about two inches long, the lower third of the sternomastoid area. Some superficial clots were carefully removed, nothing was bleeding; the neck was not swollen, pulsation could be felt over the whole length of the carotid artery. After the wound had been cleansed it was lightly packed with gauze. Apart from a little motor trouble in the left upper extremity, indicating a superficial lesion of the brachial plexus, healing took place without any complication.

It is a very different matter when the common carotid or one of its two divisions is largely involved.

The wounded man falls, covered with blood, and his life is in the hands of the nearest bystander; if he is alone death results in a few moments.

Apply the tips of the fingers over the lower part of the anterior border of the sternomastoid, and compress the common carotid artery against the hard surface of the vertebral column, along the line of the transverse processes, opposite the prominent tubercle of the sixth (*Fig.* 152): that is the first movement, which ought to be, so to speak, instinctive. Properly done, calmly and without hurry, it is often sufficient to temporarily stop the bleeding; if it fails, one or both index fingers should be introduced to

the bottom of the wound, and there compress the bleeding vessel directly. These are real life-saving procedures which lie in the power of any man with initiative and a cool head. Larrey has related the case of Arrighi, Duke of Padua, who having had his internal carotid cut by a bullet, was saved by one of his soldiers, who had the presence of mind to plunge his finger into the wound and so to check the bleeding.

Usually we are not present at the accident, and if by good chance the first non-professional efforts have been successful in preventing a fatal issue, they have seldom been able to prevent the patient losing a very large quantity of blood, and we find him with the neck distended by an enormous

Fig. 152.—Digital compression of the common carotid artery.

hæmatoma. The necessary treatment is as difficult and dangerous as it can well be; the patient can be saved, however, if one knows what should be done and can do it quickly and methodically.[1]

Any blind haphazard application of pressure forceps in the depths of the wound must be resolutely avoided. Undoubtedly, with two clamps gripping all the tissues of the side of the neck *en masse* hæmostasis can be effected,

[1] Our predecessors have left us many excellent examples of that magnificent coolness, that perfect mastery of hand and mind, which have in all ages characterized the true surgical temperament. A case related by Michon is worthy of being quoted. A young girl had received a knife stab in the lower part of the right subhyoid region, which had penetrated below the sternomastoid muscle. Blood poured out profusely; she had, however, strength to run across the street to a chemist's shop. "When I arrived," writes Michon, "I found the patient lying on a mattress in the back shop. Our confrère Picard had at once introduced his finger into the wound, and by cleverly applied compression had succeeded in checking the bleeding. I knelt down beside the patient, who was almost bloodless. I examined her neck, which was swollen by the quantity of blood effused under the skin; in my turn I introduced a finger into the wound to determine its direction and what vessel was wounded. In that moment a jet of bright-red blood escaped from the wound: there was no time to be lost. To give myself more freedom of action, I enlarged the wound upwards, and I also made a second incision in the middle line parallel to the trachea, with the idea of looking as much for the main innominate

and will probably be completed by leaving a forest of pressure-forceps in position in the wound. In all probability the vagus, and possibly the cervical sympathetic, will have been caught, along with the vessels; the great vessels themselves are probably imperfectly compressed, in a manner not at

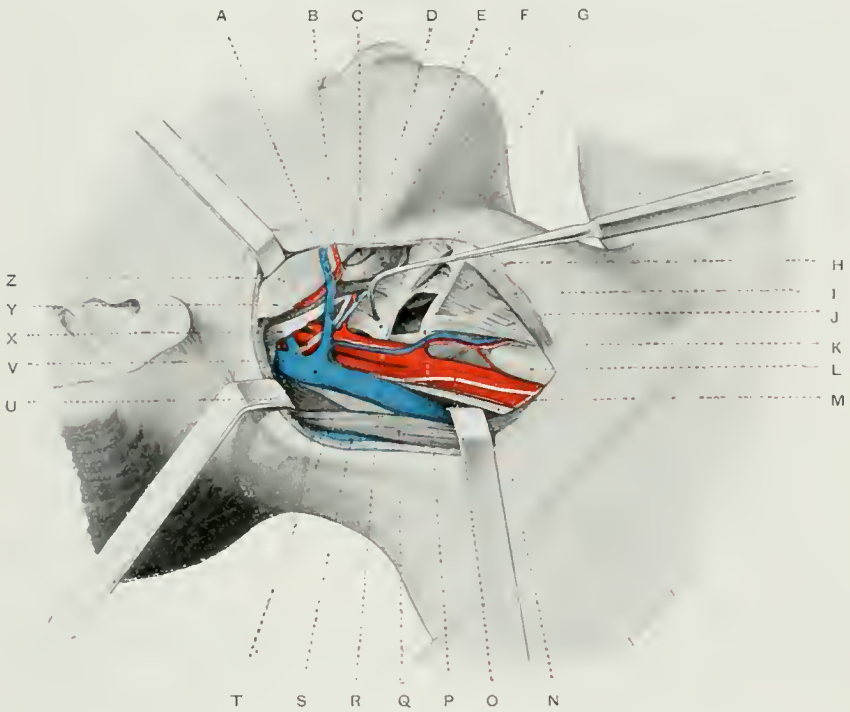


Fig. 153.—The side of the neck. (A) Facial vein. (B) Facial artery. (C) Submaxillary lymphatic gland. (D) Lingual vein. (E) Submaxillary gland. (F) Great cornu of the hyoid bone fixed by an aneurysm needle; below it is seen the superior laryngeal nerve. (G) Epiglottis. (H) Thyrohyoid muscle, cut. (I) Omohyoid muscle. (J) Sternohyoid muscle. (K) Superior thyroid vessels. (L) Œsophagus. (M) Common carotid. (N) Vagus nerve. (O) Descending branch of the hypoglossal nerve. (P) Superior cornu of the thyroid cartilage, with attachment of the middle constrictor of the pharynx. (Q) Sternomastoid muscle. (R) External carotid artery. (S) External jugular vein. (T) Internal carotid artery. (U) Internal jugular vein. (V) Hypoglossal nerve. (X) Posterior belly of the digastric. (Y) Origin of the facial artery. (Z) Lingual artery. (The thyrohyoid muscle is cut across, the thyrohyoid membrane resected, and the pharynx opened laterally to show the epiglottis).

all likely to be followed by satisfactory natural occlusion, and further, in the narrow infected wound all the conditions necessary for secondary hæmorrhage are present. In cases where bleeding has been checked in this way,

trunk as for the common carotid artery. The hæmorrhagic effusion rendered the exact determination of the relationships difficult. I had carried the left index finger to the posterior part of the wound in such a manner that while raising the parts I at the same time compressed the wounded artery. I applied one ligature, thinking I had got hold of the artery, but the loop had occluded only a muscular branch. I then noticed that there were two jets of blood, the one coming from below, the other from above. This circumstance encouraged me, because I now thought that it was the common carotid which was cut transversely, and not the innominate trunk. Having tied the upper end, I set myself to look for the lower. For this purpose I passed a blunt needle backwards, close to the upper border of the sternum, and succeeded in ligaturing the artery." (Michon, "Ligature de l'artère carotide primitive droite à la suite d'une plaie par instrument tranchant." *Bull. de la Soc. de chir.*, 1852–1853, p. 48).

I have frequently seen the patient, exhausted and bloodless, with an awkward bundle of forceps, perhaps ten or a dozen pairs, fixed with difficulty and enveloped by the dressing, hanging to the side of his neck; too often such treatment merely defers the fatal issue.[1]

The only safe rule is this: **apply direct ligatures to the two cut ends in the wound, and if that is not possible, then apply a direct ligature to the main trunk on the proximal side of the wound.**

The surgeon should have the common carotid compressed against Chassaignac's tubercle (the prominent tubercle of the transverse process of the 6th cervical vertebra), or if alone, compress it himself with the fingers of the left hand whilst working with the right. Whatever the direction of the wound, enlarge it vertically, following the direction of the sterno-mastoid, which is always a valuable guide. Retract the muscular fasciculi, or better, clear the anterior border of the muscle, and draw it aside and expose the wounded area. Armed with a pair of pressure-forceps, go over the bleeding points. If it is necessary, relax the pressure of the fingers a little: a jet of blood puts one on the track. Seize the gaping vessel, but take care to seize it alone. Once having got hold of the lower end, which sometimes is retracted to a considerable distance if the vessel has been completely cut across, look for the other end, which bleeds less or perhaps not at all, and apply forceps to any secondary branches which are bleeding.

Fig. 154.—Deschamps' aneurysm needle.

Before proceeding to tie the ligatures, make sure that the artery alone has been caught in the jaws of the forceps, and also that the ligature (silk or catgut of medium thickness) includes nothing but the vessel.

Instead of slipping the thread over the end of the forceps, it is often better to clean[2] a segment of the vessel a little lower down and to pass the ligature around it by means of Cooper's or Deschamps' needle (*Fig.* 154), or simply with the aid of forceps or a director. Tighten the ligature steadily and strongly; if there is any doubt about its security, do not hesitate to apply a double ligature. The wound will then be carefully cleansed and partially sutured, or if any oozing still persists, will be lightly packed with aseptic gauze.

[1] The leaving of pressure-forceps *in situ* is nevertheless a very valuable, indeed the only available, resource in certain cases.

[2] Let us here point out that the "cleaning" of the vessel should always be done methodically and *limited to a very short segment.* Le Fort protested, with good reason, against the too common custom, often acquired during the performance of operations on the dead body, of stripping a considerable length of the artery, which when deprived of its *vasa vasorum* is very prone to secondary ulceration under the ligature.

Wounds of the jugular vein are perhaps even more serious, and in any case more troublesome to treat than those of the carotid artery; the large vein is collapsed and appears only as an empty pale-coloured tube which is recognized with difficulty; its walls are friable and tear readily under the jaws of the forceps. Packing alone cannot be depended on definitely to control the bleeding; *ligature of the two ends, complete circumferential ligature*, is imperative. Lateral ligatures give no security; therefore, if the bleeding has been arrested by the lateral application of forceps, do not try to slip a ligature over the end, but take advantage of the cessation of hæmorrhage to isolate the venous trunk, pass a double ligature around it, and tie it above and below the wounded point.

This direct ligation of the cut vessels, *in the wound*, is sometimes impracticable,[1] because of the seat of the wound, or again because of the conditions in which one may be placed. Thus in injuries of the parotid region, some deep wounds of the upper part of the neck, or wounds of the pharynx involving the internal carotid, any attempts to carry out the rule of ligaturing the cut ends would require very extensive enlargement of the primary wound, and would also, without any certain benefit, introduce fresh dangers.

Another possible contraindication is not less important: one may be alone, without an assistant, without adequate light: to undertake a long and minute dissection under such circumstances on a patient already bloodless, would be to incur a very grave risk of his dying under one's hands.

The proper treatment in such a case (and I would add also, in any case where the injury involves either of the two main divisions of the common carotid) is **the ligature of the common carotid.**

This ligature will be applied to the artery *on the proximal side of the wound*, through a special incision if possible. Owing to the infiltration of the tissues with blood, the operation is not always as easy as it is on the dead subject; the best guides are the sternomastoid, the trachea, the transverse processes of the cervical vertebræ, and the pulsation of the vessel; remember that the jugular vein lies to the outer side and often partly overlaps the artery, and that the vagus nerve lies behind (*Fig.* 153). Once the carotid is ligated, the injured area will be carefully cleansed and packed. Asepsis is the best means of preventing any recurrence of bleeding

[1] It is at least extremely difficult in some wounds, particularly those in the supraclavicular region (*Fig.* 155), where all the large vessels run together. Such wounds bleed terribly, but it is impossible to say which vessel is bleeding, and it is also impossible to apply pressure on the proximal side of the bleeding area. In such a case the best plan is to at once enlarge the wound freely and apply direct pressure to the whole region with a large gauze swab, which is then raised from one edge little by little to see whence the blood comes. If the bleeding point is thus detected, firm pressure is applied directly to it, and advantage is taken of the temporary respite to cleanse the rest of the wound and determine the position and relationships; do not try to catch the bleeding point with pressure-forceps. The wound may involve the common carotid artery or the internal jugular vein, the subclavian artery or vein, the inferior thyroid artery, the vertebral artery, or several of these vessels together, or perhaps the innominate vein. In the last case, venous suture ought to be attempted, following the example of Ricard. (See WOUNDS AND RUPTURES OF THE LARGE VESSELS.)

from the upper cut end of the arterial trunk, and also of preventing the secondary cerebral complications which sometimes ensue.[1]

When the upper cut end is inaccessible, and hæmorrhage recurs after ligature of the common carotid on the injured side, it may become necessary

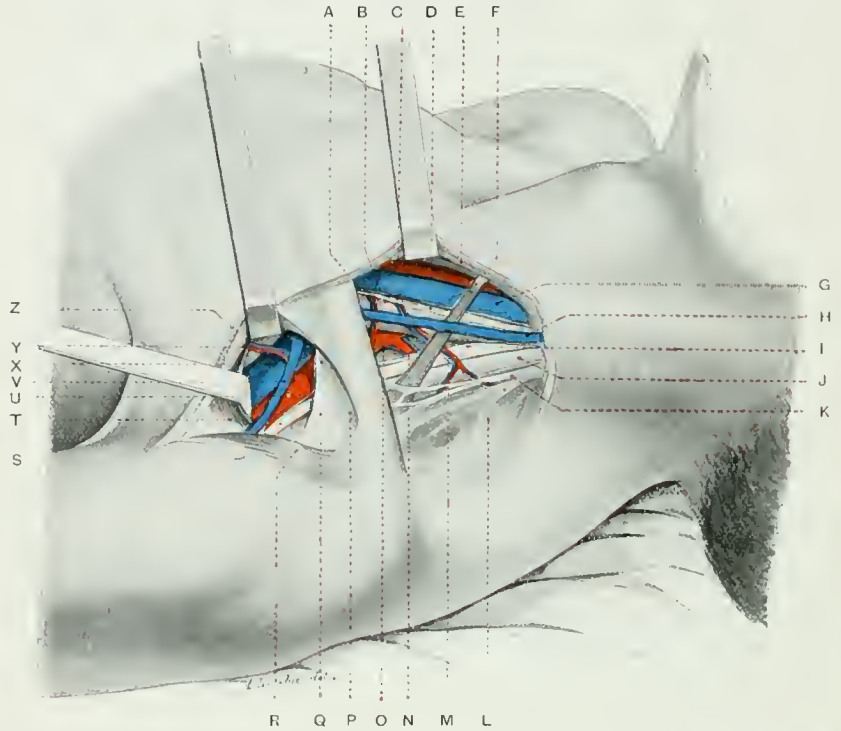


Fig. 155.—Supra- and infra-clavicular regions. (A) Suprascapular artery. (S) Scalenus anticus muscle. (C) Common carotid artery. (D) Phrenic nerve. (E) Posterior border of the sternomastoid. (F) Omo-hyoid muscle. (G) Internal jugular vein. (H) External jugular vein. (I) Nerves of the brachial plexus. (J) Scalenus posticus muscle. (K) Descending superficial branches of the cervical plexus. (L) Trapezius muscle. (M) Superficial transverse cervical artery. (N) Po-terior scapular artery. (O) Subclavian artery. (P) Subclavius muscle. (Q) Costo-coracoid membrane. (R) Deltoid. (S) Outer head of the median nerve. (T) Upper border of the pectoralis minor. (U) Axillary artery. (V) Terminal portion of the cephalic vein. (X) Axillary vein. (Y) Acromio-thoracic artery. (Z) Retracted outer border of the pectoralis major.

to tie the opposite common carotid. This serious condition has repeatedly occurred in cases of bleeding from the ear, resulting from injuries (see GUNSHOT WOUNDS OF THE EAR), or been due to ulceration of the internal carotid in cases of caries of the petrous portion of the temporal bone.

[1] There is no doubt that in many cases cerebral softening and hemiplegia are due to ascending thrombosis beginning at a septic ligature or in a septic wound. It is therefore infection, not the occlusion of the artery, which constitutes the danger from the application of a ligature to the carotid trunk. However, it must be kept in mind that certain abnormalities of the carotid arteries occasionally occur, one of the vessels being much too small to adequately supply the brain by itself: before applying a ligature to one carotid, it is therefore always well to examine the other, and determine the amplitude of its pulsations. But naturally in the vascular wounds and dangerous hæmorrhages which we are discussing, such an examination is of doubtful value; one must ligature, without hesitation and without loss of time; but it will be wise to give a guarded prognosis, and to indicate the possibility of cerebral complications, especially when the patient is elderly.

Before committing oneself definitely to complete occlusion of the second carotid artery, it would be well to try the method of *temporary ligature* recommended by Treves :[1] the vessel is exposed, a catgut ligature passed round it and tightened moderately, and the two ends of the ligature are brought out between the lips of the wound, which is left open ; after a period of from half an hour to ten hours the temporary ligature is removed, because if left longer in position it would produce the same results as a permanent one.

What has been said with regard to wounds of the carotid arteries applies equally to those of the subclavian : in wounds at the root of the neck, in the supraclavicular triangle (*Fig.* 155), *the two cut ends of the wounded vessel must be tied*, the superficial wound being enlarged if necessary : if this is impossible, then the subclavian must be ligated in continuity as close as possible to its point of origin.

Secondary Hæmorrhage.—In the event of serious secondary hæmorrhage from a wound in the middle part of the neck, we are again compelled to have recourse to *ligature of the common carotid.*

Case 9.—A man thirty years of age killed his mistress, and then attempted to commit suicide, firing a revolver shot at the left side of his neck, below the jaw ; the primary hæmorrhage, which was very profuse, was checked by compression, and when the patient was admitted to hospital some days later, a small circular blackened suppurating wound was found in the supra-hyoid region. On the seventh day sudden hæmorrhage occurred ; the dressing was soaked with blood in a few minutes ; firm pressure, however, stopped the bleeding. Eight days later hæmorrhage again recurred, bright-red blood escaping from the wound more freely even than before. Temporary compression with the finger was applied, and I forthwith tied the common carotid. Convalescence took place without any further trouble.

The above case shows that though packing and compression may sometimes check a first attack of secondary hæmorrhage, and though no further bleeding may occur, yet it is impossible to depend on such a result, nor is it advisable to trust to such uncertain methods. Secondary hæmorrhage means this : *the wound is septic, and therefore the natural healing of the injured vessels is checked.* A purely mechanical procedure, like compression, cannot correct such pathological conditions.

We must recognize that any patient with a wound in the neck and who has had a serious secondary hæmorrhage, even if packing and compression have apparently succeeded, remains in danger of sudden death ; we must therefore keep him under the closest observation, and be ready to do what is necessary at once if bleeding recurs.

The necessary treatment is as follows : Open the wound, enlarge and cleanse it, endeavour to apply forceps to the two ends. If they are friable and will not hold a ligature, then prolong the incision downwards, and at a suitable distance tie the lower segment in continuity. **Friability of the**

[1] Treves : Medical Society of London, 9 Jan., 1898.

vessels in an infected wound is a constant condition; it is sometimes very marked and involves considerable lengths of the affected vessels; any attempts to tie the bleeding points directly in such a wound almost necessarily result in considerable loss of blood (the more to be regretted as the patient's condition is already serious) owing to the tearing of the vessels on the application of the forceps. Therefore, when the wound is comparatively old, suppurating, with the surrounding tissues thickened and infiltrated (particularly after wounds with firearms), it is the best and wisest practice, if the seat of the injury permits, *to at once tie the main trunk on the proximal side*,[1] through a separate incision, made in such a manner as will best preserve it from infection.

The same plan holds good in dealing with hæmorrhage due to ulceration of the large vessels in areas of suppuration. These accidents, when occurring in the neck, may be divided into two classes: (1) When the suppuration and the resulting vascular ulceration are seated in quite *the upper part of the neck* (tonsillar abscesses, pharyngeal ulcerations,[2] submaxillary abscess, etc.); and (2) When the suppuration is in *the sternomastoid region*.

In the first group—to which it is convenient to add bleedings from the ear due to ulceration of the internal carotid, secondary to disease of the temporal bone—one must never think of tying the vessel in the region whence the bleeding comes: it is practically impossible. The bleeding can be temporarily controlled by compression of the carotid at the tubercle of the transverse process of the sixth cervical vertebra (Chassaignac's tubercle), or by direct digital compression at the bleeding point, or by the

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[1] Cras has reported a case of this kind which deserves repeating, as it shows what can be done in urgent surgery with some determination. It concerned a Breton peasant who had been gored by a cow; the horn had entered behind the angle of the jaw on the right side and had perforated the tonsil. Primary hæmorrhage was followed later by repeated attacks of secondary hæmorrhage. During one of these attacks Cras was sent for at night in great haste. "I found the patient sitting on his bed, the sheets of which were covered with bloodstains; his face was blanched and his mouth full of a coagulated mass of lint and blood blackened by perchloride of iron. As soon as the bleeding began (from the mouth) he had taken his bottle of perchloride of iron, poured some of the contents over a piece of lint, and stuffed the mass into his mouth, holding it in position by the pressure of the jaws until my arrival. He pointed to the bedroom utensil, which contained about two pints of blood. He had also swallowed a good deal. I found myself in the middle of the night, with no assistants but an innkeeper and his wife, dealing with a patient whose respiration was rendered very difficult by the horrible mass in his mouth. The rapidity with which the blood had filled the vessel led me to think that there was an erosion of the internal carotid, which had probably been lacerated at the time of the primary injury.

"I decided to ligate the common carotid at once. I cleared the patient's mouth of part of the mass which filled it. Lighted by the innkeeper, his wife, and a neighbour, I made the incision in the skin, beginning at the level of the lower angle of the external wound. Notwithstanding the inflammatory induration of the tissues I succeeded without much difficulty in stripping up the sternomastoid, and, working very cautiously, in defining the artery. It was at a terrible depth: the large internal jugular vein flattened out under my finger during inspiration, and swelled up enormously during expiration. I dared not attempt to clean it, and I could only occasionally see the artery. However, I succeeded in separating it from the vein, and tried, notwithstanding the inadequate assistance, to pass the ligature around it. Finally I had to give up this last step for fear of including the vagus nerve or wounding the vein. I packed the wound with carbolic wool and withdrew, after having shown the innkeeper how to apply pressure directly on the artery in the event of a recurrence of the bleeding.

"Next morning the patient was taken to the hospital at Brest, and I was able to pass a ligature of No. 3 catgut around the artery, not without having cleared the sternomastoid and divided the omo-hyoid, however. The patient recovered and left the hospital a month later." (Cras, Ligatures dans la continuité des artères par le catgut. *Bull. de la Soc. de chir.*, 1884, t. x., p. 733).

[2] Ehrmann, "Ulcération de la carotide interne par les abcès amygdaliens et les ulcères phagédéniques de la région." (*Bull. de la Soc. de chir.*, 1878, p. 664.)

application of long forceps with one blade in the mouth on the tonsil, the other externally on the neck, as the exigencies of the case may demand; the common carotid artery must then be immediately ligatured.

Even in the second group, although the bleeding area can be readily exposed, little trust can be placed in local ligatures, because of the friability of the arterial walls already mentioned. In one case I remember, the common carotid had been ulcerated where it was in contact with a suppurating goitre; attempts were made to ligature it in the vicinity of the perforation, the region being freely opened up; but the artery cut through on the slightest pressure with the ligature or tore under the forceps, and it was necessary to descend from ligature to ligature till the innominate artery was reached. Such extensive softening is fortunately exceptional, but it is always better to apply the ligature at once to a healthy segment of the vessel on the proximal side of the diseased area.

Lastly, if the bleeding recurs after ligating the common carotid, then if possible *the external carotid* on the same side should be tied, because the free anastomosis between the two carotid systems sometimes allows a reflux of blood through the upper end; should hæmorrhage still continue or recur, *the common carotid of the opposite side* must be ligatured if digital compression or temporary ligature has been tried and failed.

II.—WOUNDS OF THE LARYNX AND TRACHEA.

These injuries are comparatively rare in military surgery,[1] and in civil practice are almost always caused by cutting instruments, rarely by firearms.

In suicidal attempts, when the throat is cut with a razor, the position of the opening in the larynx or trachea varies; but as a rule the great vessels escape, and the cut—which is usually oblique downwards and to the right, is deepest at the centre, and tails off at the extremities—exposes the carotids without injuring them. Hæmorrhage is nevertheless a serious danger in these laryngo-tracheal wounds, particularly as a factor in causing asphyxia.

Asphyxia.—Immediate asphyxia—due to irruption of blood into the air passages—and secondary asphyxia—from œdema of the glottis, compression or obstruction due to peri- or intratracheal effusion of blood—are the chief accidents to be feared.

In practice, it is useful to distinguish (1) *Incised wounds* of the thyro-hyoid region, the thyroid cartilage, the crico-thyroid membrane, or of the trachea; (2) *Punctures*; (3) *Contused wounds and gunshot wounds* of the larynx and trachea.

1. **Incised Wounds.** (*a*). The Thyro-hyoid Region.—The accident has just occurred; above the *pomum Adami* is found a transverse wound

[1] According to Witte, they have been observed only about five times in 10,000 wounded. "Verwundungen des Kehlkopfes und prophylaktische Tracheotomie bei Denselben" (*Arch. f. klin. Chir.*, 1877, Bd. xxi., p. 182).

from which blood, saliva, and air are escaping. When the patient's head is extended, the lips of the wound separate, and through the gaping fissure is seen the epiglottis detached, the pharynx opened, and, below, the laryngeal cavity. With the head thus raised the respiratory difficulty becomes extreme; it diminishes or disappears altogether when the head is flexed; in the latter position, and when a finger is applied over the wound, the voice returns.

Carefully check all bleeding, then cover the wound with a loose dressing, keep the patient's head in the flexed position, and make arrangements for feeding by the œsophageal tube. **Introduce no sutures, neither deep nor superficial:** the wound will as a general rule unite without difficulty.

In ordinary cases these steps constitute the necessary as well as the safest practice.

If the wound is quite recent, large, and clean cut, and if the patient can be kept under the closest observation, suture of the divided thyro-hyoid membrane, and particularly of the epiglottis, will prevent the cicatricial contractions and consequent difficulties in swallowing which have sometimes been observed. If this plan be adopted, the various tissues—thyro-hyoid, musculo-aponeurotic—and cutaneous, will be united layer by layer with continuous or interrupted sutures of silk or catgut.

Instead of this somewhat dangerous practice, it is much better, as a general rule, to enlarge the skin wound if it is small, in order to provide good drainage and to guard against the infection and œdema which might result from the retention of secretions.

(*b*). **Incised Wounds of the Thyroid Cartilage.**—Both wings of the thyroid cartilage have been divided, and the laryngeal cavity is widely exposed.

If bleeding has not been severe, if it has ceased or is easily checked, if respiration is carried on satisfactorily by the wound, the method just indicated, *which is limited to cleansing and protecting the injured area and maintaining the head in the flexed position*, may be adopted.

This is not the best practice, however, nor even the safest; the larynx so freely exposed is liable to subsequent inflammatory obstruction, and cicatrization will not take place without some deformity or stenosis, or perhaps the formation of a fistula.

The plan we prefer is the following: first of all, perform high tracheotomy or inter-crico-thyroid laryngotomy, and after respiration has in this way been safeguarded, suture the two portions of the thyroid cartilage. Chloroform may be given if the administration is carefully watched, and in any case the operation should not take long.

Once the tube is in the trachea, the laryngeal wound will be trimmed up and disinfected, and the divided cartilage brought together by two or three points of suture on each side. The sutures should not pass through the mucous membrane. If the thyroid is still cartilaginous this suture is comparatively easily performed with a full-curved needle, and accurate approximation of the margins can be obtained. Even where the cartilage is ossified, it is exceptional not to be able to find some points which will

allow the needle to pass. The edges of the musculo-aponeurotic layer are then brought together with a continuous suture and the skin wound closed. The tracheal cannula, which is only employed as a precautionary measure, should be removed as soon as possible.

It cannot be denied that some most excellent results have followed simple suture of the laryngeal wound, without a preliminary tracheotomy ;[1] it is nevertheless dangerous, at least in the ordinary conditions of urgent surgery, and the practitioner ought to be warned of the responsibility which the practice entails.

(*c*). **Incised Wounds of the Cricothyroid Membrane.**—Here, again, if the wound is small, if there are no complications, and the patient can breathe easily, we should limit ourselves to carefully cleansing the wound, enveloping the neck with an aseptic dressing, and maintaining the head in a flexed position. Experience shows that healing is generally obtained without trouble.

In the case of a large, recent, non-infected wound, and in the conditions favourable to close supervision which we have already specified, *immediate suture, in layers, of the cricothyroid membrane and the different planes of divided tissues is good practice.* Morestin[2] has published an interesting case of this kind in which the wound, slightly oblique downwards and to the right, corresponded to the cricothyroid space. The larynx had been opened at the level of that space, and through the gaping wound the posterior wall of the canal could be seen : on the left side the wound involved the lower part of the thyroid cartilage. There was no emphysema or hæmorrhagic infiltration of the surrounding tissues.

The cricothyroid membrane and the detached portion of the thyroid cartilage were first of all united by interrupted sutures, which did not pass through the mucosa, a curved Reverdin needle and No. 00 catgut being used ; other catgut sutures brought together the divided cricothyroid and infra-hyoid muscles, and the skin was sutured with silkworm gut. Healing took place in eight days without any complication.

(*d*). **Incised Wounds of the Trachea**—complete or partial.—When the trachea is *completely* divided, the lower end retracts towards the root of the neck, and the blood runs into the interior of the tube and chokes up the bronchioles, threatening immediate asphyxia. Seize the severed lower end of the tube with forceps, or a hook, or the fingers, and bring it up into the wound *to the air* ; that must be done immediately, or death is a question of minutes ; at all hazards it is necessary to get hold of the lower tracheal

[1] For instance, in Prestat's well-known case of a transverse wound of the neck, produced with a razor in an attempt at suicide, exposing the interior of the larynx, which was completely divided at the level of the upper third of the thyroid cartilage ; the glottis was uninjured. Prestat sutured the two portions of the thyroid cartilage together, keeping the sutures outside the mucosa. Healing took place without any complications. ("Plaie du larynx ; suture de la plaie laryngienne ; guérison par première intention." *Bull. de la Soc. de chir.*, 1869, p. 327.)

[2] Morestin, "Plaie transversale du larynx, au niveau de l'espace thyro-cricoïdien, suture hermétique du larynx, du plan musculo-aponévrotique et de la peau ; guérison en huit jours," *Gaz. des hôp.*, 6 fev., 1900.

segment: if it has retracted far down, the skin must be incised longitudinally in the middle line in order to reach it. As soon as it has been seized (*Fig.* 156), the air-passages must be cleared by coughing (provoked by stimulation of the interior of the trachea), by artificial respiration, or if necessary by suction.

In less urgent conditions, where the bleeding has been moderate and asphyxia is not immediately impending, it is quite as important to *seek for, raise and secure the lower end of the trachea.*

One may now, if no better alternative offers, fix it to the skin by a few interrupted sutures: but this should only be a compulsory or temporary measure; employed as a permanent method, it involves some impairment of the voice. Even if the lower end be raised and fixed to the skin high enough to be in contact with the laryngeal end, the adjustment will always be too incomplete and uncertain to prevent ultimate cicatricial stenosis.

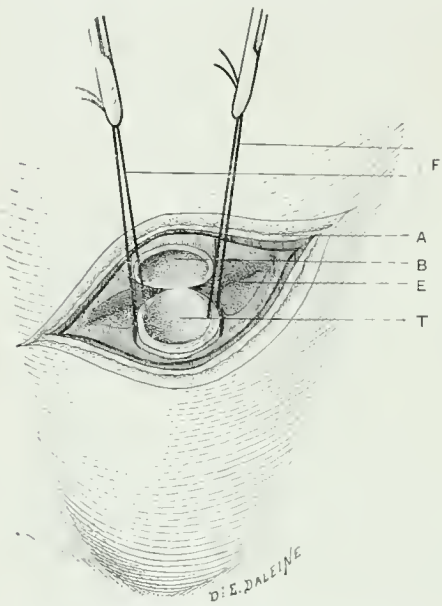

Fig. 156.—Oblique wound of the neck; division of the trachea. Raising the lower end by means of two traction threads. (F) Threads attached to the tracheal end, retracted. (A) Cervical aponeurosis. (B) Upper cut end of the trachea. (E) Deep planes of peritracheal tissues. (T) Lower cut end of the trachea.

The proper method is as follows: the lower end is raised and held in position by two pairs of Kocher forceps, or two threads passed through the lateral margins; then a vertical incision is made in the middle line of the tube, dividing the upper two or three tracheal rings, and into the opening a tracheotomy tube is introduced; then, behind and on either side, the two segments are adjusted accurately by a sufficient number of interrupted sutures passed at right angles to the cut edges, and excluding, as far as possible, the mucosa.[1]

Wounds of the trachea are, however, more frequently *partial* and oblique. The more nearly they approach the transverse direction the more they gape, and the eruption of blood into the gaping opening of the tube may again require, as a measure of extreme urgency, the immediate enlargement of the wound and the introduction of a cannula into the trachea, with the evacuation of the blood by aspiration.

[1] If the wound has been quite recently inflicted, is clean-cut, and the patient under conditions favourable for continuous observation, complete circular suture of the two segments may be made, with the reservations we have already mentioned when speaking of wounds of the larynx.

In these cases, after the bleeding has been checked, the wound may be left, subject to the precautions already indicated, unsutured, simply covered with a light, loose dressing. Healing will usually occur without difficulty, but not always without some stenosis.

However, in all *recently inflicted incised wounds which are not infected, and when the patient can be kept under close observation*, immediate suture (*Fig.* 157) is, in our opinion, the best method, and ought to be the method of choice.

Case 10.—A woman about forty years of age had cut her throat with a razor; she was admitted to the Beaujon Hospital covered with blood; there was a large oblique wound, about three fingers' breadth in length, in the lower third of the neck; pressure-forceps were applied to a large vessel, which was bleeding, and as the patient was breathing easily, further treatment was limited to the application of a dressing.

Next day the patient was breathing perfectly well, although the dressing prevented the entry of air by the wound; the wound was opened up, however; it was then found that there was an oblique opening in the trachea, about an inch long, involving two thirds of the circumference of the tube; the forceps applied the previous day were found to be on the internal jugular vein; the carotid artery was exposed but not damaged. The jugular vein was ligated above and below the forceps, which were then removed; four catgut sutures passed obliquely through the thickness of the neighbouring cartilaginous rings, *without penetrating the mucous lining*, brought the two lips of the tracheal wound together. The external wound was then carefully disinfected and closed at the extremities only, a small drainage tube being placed at the centre. Healing took place without the least trouble, and the patient left the hospital at the end of a fortnight without the slightest respiratory difficulty.

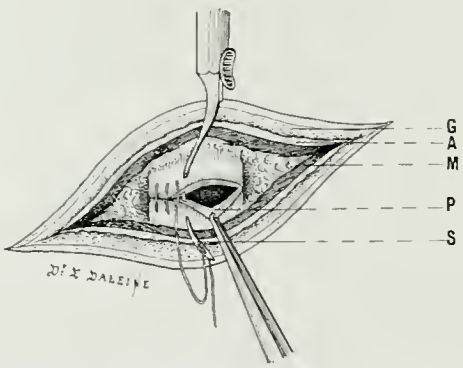

Fig. 157.—Suturing the trachea. (G) Subcutaneous fatty tissue. (A) Cervical aponeurosis. (M) Infrahyoid muscles. (P) Mucous membrane. (S) Needle passing the suture through the wall of the trachea outside the mucous membrane.

The tracheal wound may be closed by means of a continuous suture, as shown in *Fig.* 157, or by interrupted sutures, the latter method being often the easier; care should be taken to avoid carrying the sutures through the mucous membrane, although one or two perforating sutures of catgut may cause no trouble[1] and may make the closure more secure. Careful and accurate adjustment is essential to avoid any diminution of the calibre of the tube.[2]

[1] See Mesnard, *Traitement par la suture des plaies par instrument tranchant du conduit laryngo-trachéal*, Thèse doct., 1901, p. 23.

[2] Wounds with loss of tissue require some mention: as a rule they necessitate the immediate introduction of a tracheal tube, and are ill adapted for any immediate attempts at repair. We may, however, recall an interesting case reported by Mesnard: a lunatic, in attempting to commit suicide, had made many cuts across the front of the neck with a razor. There was a

2. **Small, and Punctured Wounds of the Larynx and Trachea.**—The diagnosis of penetration is sometimes difficult, and serious respiratory difficulties may develop very suddenly. Subcutaneous emphysema and blood-stained sputum are the most valuable diagnostic factors in a doubtful case. These require the closest surveillance; everything must be ready for the performance of tracheotomy, which should be done on the appearance of the least sign of asphyxia.

3. **Contused, and Gunshot Wounds.**—Contused wounds are usually associated with lesions similar to those seen in fractures of the larynx; the cartilages are broken, the fragments are displaced and overlap, there are irregular lacerations of the mucous lining, etc.; even if there are no immediate symptoms of asphyxia, all the conditions necessary for their subsequent appearance are present.

In these cases no attempt whatever at closing the wound should be made: if the patient need not be moved and can remain in absolute quietude under medical observation, and if respiration is satisfactory, treatment may be limited to cleansing the wound, excising any partly detached tags of tissue, replacing dislocated fragments, and fulfilling any general indications. As a rule, however, particularly in the country, and where constant supervision cannot be exercised, **immediate tracheotomy ought to be performed**; this will enable the laryngeal wound to be treated effectually.

Gunshot wounds of the laryngo-tracheal tract are uncommon in military surgery, still more so in civil practice.[1] Further, civil weapons do not cause the large wounds and extensive destruction produced by, for example, a fragment of a bursting shell. Almost invariably they are small circular wounds, and, wherever situated, penetration of the canal is indicated by bloody expectoration, dyspnœa, and emphysema, and sometimes by the escape of air or mucus from the wound.

Because of the smallness of the cutaneous opening and the special characters possessed by these gunshot wounds, preventive tracheotomy is indicated, and should be performed at once without waiting for the development of symptoms of asphyxia.

The rule is simple: if it is proved that the bullet has injured the larynx or trachea, **tracheotomy should be done at once**, if possible before moving the patient, and without waiting for the appearance of signs of asphyxia.

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transverse incised wound of the thyroid cartilage below the vocal cords; lower down the cricoid and the upper tracheal rings over the whole of the anterior face of the canal, and for a length of about two inches, were literally hacked to pieces; the cartilages were cut like a piece of mosaic; a great number of very small fragments comparable to nail clippings were more or less detached. The thyroid cartilage was sutured, and also the mucous layer; there remained a loss of tissue, extending from the cricoid—the anterior part of which was wanting—to the third ring of the trachea: the opening was closed with a trellis-work of catgut (Nos. 1 and 2), the threads taking their points of support from the neighbouring cartilages, crossing and intercrossing with one another, and including all the tissue débris in a sort of meshwork. Healing ensued without any subsequent disturbance, and was confirmed by observation six months later (*Soc. de chir.*, rapport de Picqué, 21 nov., 1900, and thesis already quoted, p. 41).

[1] Charles Petit, *Des plaies par armes a feu du larynx et de la portion cervicale de la trachée*. Thèse de Paris, 1889, No. 375.

Once the tracheotomy tube is in position, one may enlarge the wound of entry, and trim and disinfect the underlying area: if profuse oozing of blood renders it necessary, pack the laryngeal cavity, which will give enough liberty of action to enable the local conditions to be dealt adequately with, and prevent the inflammatory complications, with their immediate dangers and sequelæ, which are so common after injuries of this nature.

In cases of partial lesion, such for instance as of the epiglottis, if there are no urgent indications, opening the trachea may be postponed, but such a practice always involves serious risks and should not be lightly adopted.

Lastly, in any case of injury of the laryngo-tracheal tract, where the danger of suffocation is imminent because of the sudden entry of blood into the trachea and the bronchi, the plan adopted by a Prussian lieutenant and reported by Götting[1] may be followed. At Beaumont on August 30th, 1870, he was shot in the neck by a bullet which passed from left to right through the thyroid cartilage a little above the middle, and divided the left vocal cord. Feeling himself in danger of immediate suffocation, the wounded man tore all the coverings from the front of his neck, and kneeling down, rested his forehead against the ground to prevent the blood from running into the interior of the larynx; the dyspnœa ceased, and when Dr. Götting found him on the battlefield, the bleeding had stopped and respiration was unimpeded.[2]

Let us add, that if a preliminary tracheotomy has not been performed, it is a wise practice to place the patient in Rose's position (neck fully extended and head hanging over the end of the table) while any laryngo-tracheal operations are being performed.

III.—WOUNDS AND BURNS OF THE PHARYNX AND ŒSOPHAGUS.

We need say little with regard to the wounds of the upper part of the alimentary canal, which are, besides, often associated with injuries to the respiratory passages that to a great extent govern the treatment. Here again, suture is only justifiable in the case of a recently inflicted incised wound.[3] The mucosa should be united by a continuous catgut suture, and the overlying structures by interrupted sutures passing through the whole thickness of the tissues.

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[1] In Witte, *loc. cit.*, Obs. 38, p. 494.

[2] Rhythmical tractions of the tongue may be of very great value in cases where symptoms of asphyxia immediately succeed the injury: witness a case of Matignon's, reported by Laborde to the Académie de médecine (6 nov., 1900) · during the attack on the legations at Pekin, a combatant received in the neck a ball of small calibre which perforated the trachea, without, however, wounding the great vessels. He fell, in imminent danger of asphyxia: rhythmical traction on the tongue, carried out for two or three minutes, restored the natural respiratory movements, which were followed by vomiting of blood, and the patient recovered consciousness.

[3] A case of Ricard's will serve as an example: a young man, nineteen years of age, had cut his throat with a razor: there was a large wound, slightly oblique, from above downwards and from left to right; both carotids were intact, the trachea was completely divided, and the œsophagus almost completely, a posterior "bridge" alone remaining. The œsophagus was sutured with No. 2 catgut, the trachea was closed with a continuous suture excluding the mucous layer, and the wound in the superficial tissues was partly closed and drained. Feeding was done by means of the œsophageal tube. Recovery. (In Mesnard's thesis already quoted, p. 39.)

Under other conditions, and after gunshot wounds, the best practice is *to enlarge the superficial wound, open up and drain the underlying area*, and allow the wound to heal by granulation, which usually occurs fairly quickly. While healing is taking place the patient must be fed by means of the œsophageal tube.

Burns of the pharynx and œsophagus, whether caused by steam, hot liquids, or caustic fluids, are attended with a very grave risk of œdema of the glottis and sudden asphyxia. These cases cannot be too closely watched, and tracheotomy is indicated on the first appearance of any respiratory trouble.

Feeding gives rise to a good deal of difficulty, particularly as the passage of a tube can scarcely be recommended—during the first few days at least—when the exact extent of the damage to the pharynx and gullet is unknown. It will be best to depend chiefly on rectal alimentation.

Caustic fluids may pass through the pharynx and œsophagus without causing any serious lesions, and, accumulating in the stomach, by their continued action there may sometimes produce large perforations, with the usual serious consequences. (See PERITONITIS FROM PERFORATION); but more frequently these accidents produce non-perforating burns, involving the mucous and muscular layers in the vicinity of the pylorus, or the pylorus and the cardia, or even of the whole gastric surface;[1] such conditions are indicated by intense epigastric pain, although swallowing is but little interfered with, and by gastric intolerance, followed by malnutrition, which rapidly produces a condition of cachexia.

In such circumstances gastric lavage is indicated, and should be done as soon as possible, with albumen-water or Vichy water; or if the caustic agent has been an alkali, with boiled water to which lemon juice has been added. As soon as it becomes evident that serious gastric lesions have been produced and that adequate alimentation is impossible, it is advisable to perform jejunostomy without loss of time; this will enable the patient to receive sufficient nourishment, and will at the same time put the stomach in a condition of rest favourable to healing. (See later, URGENT JEJUNOSTOMY.)

[1] An intense ulcerating gastritis results, and subsequently various cicatricial lesions of the stomach or its orifices which may render some secondary operation—usually gastro-enterostomy—necessary.

SUBCUTANEOUS INJURIES OF THE NECK.

In this section we shall deal particularly with the fractures of the larynx and trachea:[1] we need only mention the subcutaneous ruptures of the carotid arteries, and the fractures and dislocations of the cervical vertebræ, comparatively rare injuries which still more rarely demand active interference. (See DISLOCATIONS OF THE VERTEBRAL COLUMN).

Fractures of the Larynx and Trachea. — It is necessary to distinguish between crushing injuries, associated with considerable lesions and imminent danger of asphyxia, and the less serious injuries characterized by a fracture or simply by a fissure of one of the cartilages.

1. **Crushes.**—A man is knocked down by a heavily-laden wagon, two wheels of which pass over the front of his neck. He is picked up and taken home. One finds him unconscious, breathing with difficulty, his face swollen and purple, the eyes projecting, the skin cold, pulse feeble; the skin of the front of the neck is abraded and distended by an enormous swelling, which reaches from the jaw down to the front of the chest; it is a gaseous swelling, crepitating in places, and giving a resonant note on percussion. On depressing this emphysematous mass it is possible, but not without difficulty, to feel the hyoid bone and the framework of the larynx, which is distorted and flattened (sometimes the hyoid bone alone can be recognized with the finger). The emphysematous swelling is visibly enlarging and extending its borders.

Hasten to open the trachea. Immediate tracheotomy, done as best it can, with any possible instrument, is justified—demanded, I ought to say—by the near approach of death.

The operation performed under these circumstances, on a neck enormously swollen and infiltrated with air and blood, is a very different matter to the calm, slow, and methodical tracheotomy practised on the dead subject. Feel quickly for such median landmarks as still remain accessible—hyoid, angle of the thyroid, cricoid. If, as is common, no prominence is sufficiently definite, then **make a long incision in the middle line.**

Do not be alarmed at the quantity of dark blood which flows profusely from the congested veins;[2] carry the left index finger to the bottom of the wound, and feel for the cricoid ring, the inferior border of the thyroid

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[1] We shall merely mention fractures of the hyoid bone which may occur as complications of laryngo-tracheal injuries, as isolated lesions due to violent blows on the front of the neck or to forcible constriction. The isolated fractures give rise to urgent indications in the two following conditions: (1) When they are associated with symptoms of asphyxia, requiring tracheotomy; (2) When they are complicated by laceration of the mucosa and, the area becoming infected, this forms the starting-point of a large sub-hyoid and peripharyngeal abscess. (See later, SUPPURATION AND ABSCESS OF THE NECK.)

[2] The thermo-cautery would be a useful instrument in these circumstances if it allowed the operator to work as quickly as the knife. (See PANAS, "Cinq observations avec des considérations cliniques et opératoires." *Ann. des mal. de l'oreille et du larynx*, 1878, iv., i., p. 79.—Obs. I: Fracture du larynx par roue de voiture; crico-trachéotomie d'urgence, succion du sang par la canule; guérison.

cartilage, or the upper rings of the trachea; keep the finger on this landmark, and using it as a guide, plunge the scalpel into the canal and cut longitudinally. If no dilator is available, pass the tube along the left index finger, which keeps the tracheal wound open, and introduce it. Any precise rules or definite steps are impossible in such conditions: some general points alone can be mentioned. Make a long incision, keep to the middle line, keep the index finger steadily fixed on the landmark which is discovered in the depths of the wound, and once the trachea is opened, introduce the tube without precipitation, and be sure that it is placed in good position.

If the trachea is ruptured transversely and the lower end has retracted,[1] it must be sought for with the finger, and when found brought up to the surface, so that a tube may be introduced. (See WOUNDS OF THE LARYNX AND TRACHEA.)

By the time the tube has got into the trachea, asphyxia is often imminent or appears already complete, respiration has ceased, the patient is motionless, dusky, and apparently lifeless. Place him with the head low, perform artificial respiration, and aspirate the blood which is choking the air passages, by means of a rubber tube passed through the cannula.[2] When dealing with such a case of mechanically produced asphyxia the condition should never be considered as hopeless. Open the trachea and empty the bronchi: if these two indications are quickly and freely met, marvellous recoveries will sometimes be obtained. As soon as the patient begins to breathe, coughing should be induced by irritation of the trachea; this will speedily complete the work of clearing the air-passages, and the first and most urgent part of the operation is at an end.

Bleeding is then carefully checked, any clots which are obstructing the larynx are removed, depressed fragments of cartilage are elevated, and the lumen of the laryngeal cavity restored as far as possible. If any oozing of blood persists, the interior of the larynx may be packed.

When the *trachea is completely torn across*, it is well to approximate the two ends by a few points of suture (see p. 159); accurate apposition cannot be depended upon in these cases, however. In a patient of Noll's[3] the two portions of the trachea were separated by a distance of one- and- a-

[1] BEIGEL, "Ueber die Bruche der Luftröhre." *Beitr. zur klin. Chir.*, 1895, Bd. xiv., 11, p. 517.—Personal observation (v. Brun's clinic). Rupture of the trachea by the passage of a carriage wheel; immediate tracheotomy; emphysema rendered all exploration difficult; the trachea was however felt with the finger seized, brought to the surface, incised in the middle line, and a long tube introduced; artificial respiration; aspiration of the blood; the patient died after a few hours. Autopsy; transverse rupture of the trachea, a narrow segment of the posterior wall alone uniting the two ends; double fracture of the cricoid cartilage, etc.

[2] With the mouth, or better, with a large syringe. In a case where hæmorrhagic obstruction of the air-passages occurred during the course of a resection of the upper jaw, M. Latarjet, of Lyons, obtained very satisfactory results by tracheo-bronchial aspiration; apnœa was complete, the face was purple, the heart had apparently ceased to beat. Tracheotomy was performed: through the cannula a rubber tube was introduced for a distance of four or five inches, a large syringe was adapted to the end of the tube and a vacuum produced by withdrawing the piston; while the vacuum was maintained, tube and syringe were slowly drawn outwards; it was then found that the tube had brought with it a clot about six inches long; this manœuvre was repeated five or six times, each time with the same result: respiration began again, and the cyanosis disappeared; two or three further aspirations were made with negative results; the patient recovered completely. (*Bull. de la Soc. de chir. de Lyon.* 1905, no. 6, p. 231.)

[3] *Deutsche Zeitsch. f. Chir.*, 1888, Bd. xxvii., p. 597; also BEIGEL, *loc. cit.*, Obs. xvi.

half inches, and the lower end could only be raised about three-quarters of an inch; healing took place, but with such a degree of stenosis of the lower end of the larynx that it was impossible to leave out the tube; after dilatation and thyrotomy, however, a satisfactory result was obtained.

Close approximation of the two ends is not, however, absolutely essential in all cases; in one instance recorded by Long[1] the separation being about three-quarters of an inch, a long tube was placed in the lower end. The tube was removed on the ninth day, and the wound had healed in a month. Six months later a cylindrical connection, which dilated on inspiration, was evident below the larynx; it was in fact a fibrous tube which had taken the place of the upper tracheal rings. Usually, however, one could not expect healing to occur in that way without serious narrowing of the canal.

Statistics demonstrate the extreme gravity of these crushing injuries of the larynx and trachea; Hénocque,[2] out of 52 cases of fracture of the larynx, found 33 deaths and only 19 recoveries; Beigel,[3] in 33 cases of rupture of the trachea, found 22 deaths and 11 recoveries. Asphyxia is the most common cause of death; the gravity of these injuries is so much the greater because they are usually multiple, affecting both larynx and trachea, and complicated by vascular lesions.

2. **Simple Fractures.**—The prognosis is less serious in simple fractures, limited to one of the cartilages, which are produced by a blow in front or by lateral compression.

The ordinary signs of fracture may be detected: mobility, and a sort of crepitus, which is sometimes really osseous, the cartilages being ossified. Dyspnœa, bloody expectoration, and emphysema of the neck are also constant signs; they enable us to detect *the fissures*, which are not evident to direct palpation.

Even after simple fissures, submucous hæmorrhages and œdema may cause sudden danger of suffocation; therefore in such cases the development of *increasing dyspnœa* is always to be considered as an indication for tracheotomy, or intubation if the latter is practicable.

Undoubtedly expectant treatment pure and simple, when there is no depression of fragments, and no marked emphysema or dyspnœa, is attended by very satisfactory results in a certain number of cases: but these must always be closely watched, the patients kept absolutely quiet, and the doctor must hold himself in readiness for dealing instantly with any untoward development. It is well to keep in mind the sad cases which occur from time to time, of which the following may be taken as an example: a child fell, striking the front of his neck against an iron bootscraper; there was a transitory attack of suffocation. Five minutes later he was sitting near his mother, quite quiet, breathing naturally, and with the neck showing

[1] Beigel, *loc. cit.*, Obs. xv.

[2] Hénocque, "Des fractures traumatiques des cartilages du larynx." *Gaz. hebd.*, 1868, nos. 39 and 40.

[3] *Loc. cit.*

no sign of any injury. Suddenly the boy threw himself violently backwards, an enormous swelling spread rapidly over the head, neck, back, and upper extremities, and he died in a few minutes.[1]

These acutely developing emphysemas produced by the sudden opening up of a fracture which had until then remained with its margins in apposition, and perhaps altogether unperceived, must not be forgotten; and the danger of rapid suffocation, whatever may be the manner of its production, must always be an important factor in the prognosis of injuries of the larynx, in spite of their apparent primary benignity.

FOREIGN BODIES IN THE AIR PASSAGES.

We shall only include here solid foreign bodies: a sudden irruption of *liquid—pus* or *blood*—into the laryngo-tracheal canal may necessitate immediate tracheotomy, followed by aspiration with a tube, or direct suction of the obstructing material if suffocation is impending and the surgeon is called in time.

With regard to the *solid* foreign bodies, they are seen particularly in children, and are of almost infinite variety. From a practical point of view they may be divided into: (*a*) Those with smooth, regular surfaces; (*b*) Irregular, sharp-pointed, angular bodies which catch and stick, and perhaps become embedded; (*c*) Hygroscopic bodies which, absorbing moisture, swell up and plug the part of the canal in which they lie. According to statistics, peas occupy the first place,[2] then fruit stones, bits of bone, grains of corn, coffee beans, small pebbles, etc.

These bodies lodge at varying levels and give rise to symptoms which also vary; most commonly they are arrested above the glottis (supraglottic), less often within the glottis (intraglottic) or below the glottis (subglottic). In urgent surgery the problem presents itself in different forms, according as the practitioner is called at the time of the initial attack or later.

1. **The sudden entrance of a foreign body** is always indicated by an acute attack of suffocation, often very severe and requiring immediate treatment.

Arriving at this moment, the child is found purple, the mouth wide open, eyes projecting, the skin cold, and the pulse very feeble. Notwithstanding the terrible efforts and violent movements of the chest, no air enters, a short whistling sound alone marks the results of the attempts at inspiration; the indrawing of the suprasternal tissues is extreme. Suffocation is but a matter of a few moments. Carry the finger quickly to the back of the mouth, to the upper orifice of the larynx, where the foreign body, if it is of some size, may have been arrested. Perhaps it may be possible to displace

[1] Atlee, *Amer. Jour. of the Med. Sciences.* 1858, xxxv., No. 5, Obs. 1.

[2] In 72 out of 300 cases collected by Bourdillat.

and extract an over-large mouthful, or a piece of meat which had been hastily swallowed and is obstructing the whole of the throat. But however that may be, the whole manœuvre should be carried through instantaneously.

If one feels nothing, or does not succeed in removing the obstruction at the first attempt, **then open the trachea at once.** This may be done with a scalpel, the point of a scissor blade, or with a pocket knife, if there is nothing better. Give the patient air. Do not waste time in getting information about the accident, or in inverting the patient or shaking his chest, practices which are as useless as dangerous. Laryngeal asphyxia is present: the indication is a vital one. Those who have seen a tragedy of this kind know that life or death depend alone on the energy and coolness of the doctor.

Crico-tracheotomy (Boyer's operation) is an excellent method of dealing with these extremely urgent conditions. Take hold of the cricoid cartilage, nearly always easily recognizable, between the forefinger and thumb of the left hand, and plunge the point of the knife into the **crico-thyroid space** above it; go right into the laryngeal cavity at once. Air enters immediately, while the knife, cutting downwards, divides the cricoid cartilage and one or two rings of the trachea (*Fig.* 158). With a pair of forceps, the handle of the scalpel placed transversely, or the nail of the left forefinger, separate the lips of the tracheal opening, then extend the head, perform artificial respiration, and provoke coughing by stimulating the tracheal mucosa until the air-passages are clear of the blood which has entered and the patient is breathing regularly.

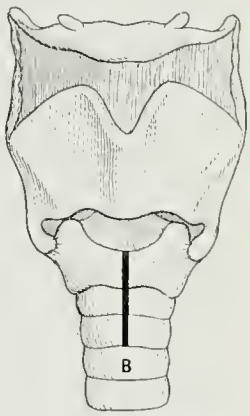


Fig. 158.—Crico-tracheotomy (diagrammatic).

We shall often find that the foreign body is expelled during the course of these manœuvres; if not, a tracheal tube is introduced and left in position; the immediate dangerous symptoms being overcome, attempts at extraction or expulsion may be deferred to another time.

2. **The violence of the initial attack has passed off,** but great dyspnœa still remains; there is indrawing of the chest, whistling inspiration, short, raucous, stridulous expiration: the voice is toneless, sometimes there is aphonia; there are repeated convulsive attacks of coughing. There is a definite pain located at some point in the larynx or trachea, accentuated by pressure.

Certain positions, varying in different cases—the horizontal position on the back or on the side, or the sitting position—often in some degree relieve the respiratory difficulty.

Dyspnœa is not, however, a constant symptom; it has a certain relationship to the shape, size, and location of the foreign body, and it is

not to be considered as an essential factor in the diagnosis. When it is lacking, the attacks of *spasmodic, expulsive* coughing, and also, as we shall see later, palpation or auscultation of the larynx and trachea during these attacks, furnish valuable data on which to found the diagnosis.

Be that as it may, the situation has become less urgent; but the frequent recurrence of suffocative attacks must not be forgotten, and therefore it should be an absolute rule not to leave the patient until the foreign body has in some way been expelled or removed, or the safety of respiration has been assured by tracheotomy.

We must therefore try to discover where the obstruction is. Is it *supraglottic* or *intraglottic*? Is it *subglottic, tracheal, or bronchial*?

Before making any examination, prepare everything for a tracheotomy; it may be required suddenly.

With the finger explore very gently the back of the throat, the aryteno-epiglottidean folds, and the openings of the pharynx and larynx; some foreign bodies riding on the partition between the two openings will be recognized, and may possibly with some dexterity *be hooked up and removed* but to avoid exciting spasm and the risk of pushing them further in, the manipulations must be gentle and rapid. Do not make a prolonged examination, but repeat it at short intervals if necessary. In some cases, and where a laryngoscope is not at hand, the method may be very useful.

The examination should always be made by means of the laryngoscope if possible; it is only practicable under general anæsthesia in young children; even with older persons, it is always very difficult in these cases: the approach of the mirror provokes attacks of coughing and dyspnœa. A propitious moment—a pause which always succeeds an attack of coughing—must be seized for illuminating the larynx.[1]

Supra- or Intraglottic Foreign Bodies.—If the foreign body is discovered under one of the aryteno-epiglottidean folds, in the vestibule, or lower down in the opening of one of the ventricles, extraction by the mouth will be practicable.

But this is not an easy undertaking for one who is not accustomed to laryngeal work; further, if badly performed, with inappropriate instruments, it may readily become dangerous, and a considerable risk is incurred of pushing the foreign body into the glottis or of exciting sudden attacks of asphyxia.

These difficulties and dangers must be kept in mind. If the extraction can be undertaken with the assistance of suitable laryngeal forceps and a well-handled laryngoscope,[2] and we might add, with some deftness and

[1] As a preliminary it is well to swab the throat with a 20 per cent solution of cocaine or stovaine, or a 10 per cent solution of eucaine.

[2] Krishaber ("Corps étranger dans le larynx: extraction par les voies naturelles." *Ann. des mal. de l'oreille et du larynx*. 1898. p. 78) recommends the following method: The patient is placed across a bed lying face downwards and with the head hanging over the edge; the doctor (who has previously determined, by means of the laryngoscope, the presence of a supraglottic obstruction) kneels in front of him and passes his left index finger down to the entrance of the larynx. Pushing the epiglottis forward and using the finger as a guide, he then introduces a slender laryngeal forceps, which grasps and removes the foreign body.

quickness of hand, the results are often very satisfactory. Always remember that it is necessary to get a firm grip of the object before attempting to extract it.

It is much better as a rule (and it is the only method applicable if chloroform has to be given) to put the patient in Rose's position, with the jaws widely separated by a gag, and the tongue drawn well forward, and then to throw a strong light on the back of the throat and the entrance of the larynx.

If the attempts are not successful, because of the operator being unaccustomed to intrabuccal manipulations, or because the foreign body is embedded in the mucous membrane or lies at too great a depth, what is to be done ?

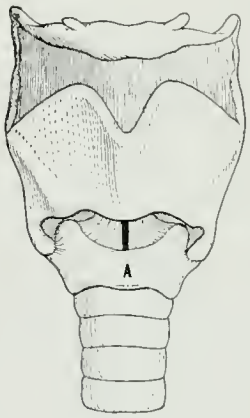


Fig. 159.—Inter-crico-thyroid laryngotomy (diagrammatic).

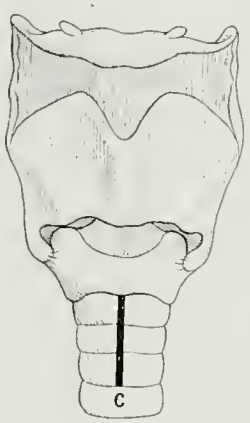


Fig. 160.—Tracheotomy (diagrammatic).

Do not procrastinate, at least if the symptoms are at all pressing. Perform tracheotomy (*Fig.* 160) or crico-tracheotomy (*Fig.* 158) if the patient is a child; inter-crico-thyroid laryngotomy (*Fig.* 159) if dealing with an adult. This is an indispensable step to ensure the patient's safety; further attempts at extraction may then if necessary be deferred for a little, and perhaps by a happy chance the offending object may be expelled by the mouth in the interval during a fit of coughing.

Do not depend too much on such a chance; the wisest plan is to take advantage of the newly-opened route to endeavour to dislodge and expel the foreign body. Place the patient with his head low and withdraw the tracheal cannula; keep the incision open with a dilator or open forceps, and through it introduce from below upwards a slightly curved director or a soft rubber catheter, through the glottis into the pharynx. A finger of the other hand placed at the back of the throat, if the obstructing body has been dislodged, may be able to direct it towards the mouth, whence it may be ejected by coughing or vomiting; at other times it will fall into the œsophagus and be swallowed.

In cases where the foreign body is *fixed* or *impacted*, and the attempts at extraction from above or below have failed, it may become necessary to make a direct way of access to it ; in such cases the operations of *subhyoid pharyngotomy* and *thyrotomy* find their indications.

Sub-hyoid pharyngotomy, first recommended in 1835 by Malgaigne, and frequently employed since,[1] consists in incising, layer by layer, the tissues of the thyrohyoid space along the lower border of the hyoid bone.[2]

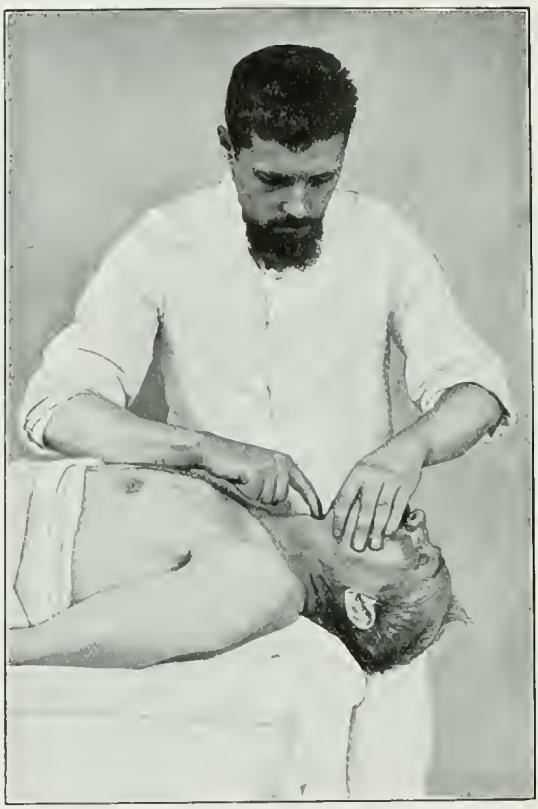


Fig. 161.—Subhyoid pharyngotomy : feeling for the thyrohyoid space.

The patient's head being moderately extended and properly steadied, the various prominences of the front of the neck stand out clearly, and the thyrohyoid space is easily seen (*Fig.* 161). Follow the inferior border of

[1] M. Honsell in 1899 collected ninety-three cases, in ten of which the operation had been performed with the object of removing a foreign body from the pharyngo-laryngeal cavity. (Honsell, " Ueber Pharyngotomie Sub-hyoidea." *Beitr. zur klin. Chir.*, Bd. xxv., 1, p. 121.)

[2] This high incision of the thyrohyoid space is preferable to the low incision along the upper border of the thyroid cartilage (suprathyroid laryngotomy) which involves the division of the epiglottis near its root, and thereby entails a risk of irregular cicatrization and subsequent stenosis.

the hyoid bone with the finger; along this border make a transverse skin incision from right to left, beginning half an inch to the inner side of the extremity of the right cornu and extending to a corresponding point on the other side. The superior laryngeal nerve and artery enter the space at its extreme posterior part and about midway between the upper and lower limits; these need not be troubled about, as they will not be met with.

Fig. 162.—The thyrohyoid space. (G) subcutaneous fatty tissue. (M) Thyrohyoid muscle. (C) Inferior border of the hyoid bone. (C') Superior border of the thyroid cartilage. (E) Thyrohyoid membrane.

Below the skin, divide first the attachments of the sternohyoid and omohyoid muscles, then the *thyrohyoid muscle* (*Fig.* 163), which is covered with a thin fibrous layer, and lastly *the yellowish and somewhat laminated thyrohyoid membrane* (*Figs.* 162, 164). The outer surface of the mucous layer is then encountered, and must be opened between the base of the tongue and the epiglottis at the level of the hyoid bone. Pinch up the membrane laterally, and make a small opening in it; then, introducing a point of the scissors, divide it transversely for the whole length of the wound. The base of the epiglottis now appears: pull this forward into the wound, and keep it in position by means of a thread passed through it or under a retractor; retract the hyoid bone upwards with a blunt hook, and you have free access to the pharynx, the supraglottic area, and the ventricles (*Fig.* 165). Once the disengaging and extraction is completed, the wound is closed in layers, the various planes of tissues being carefully adjusted.[1]

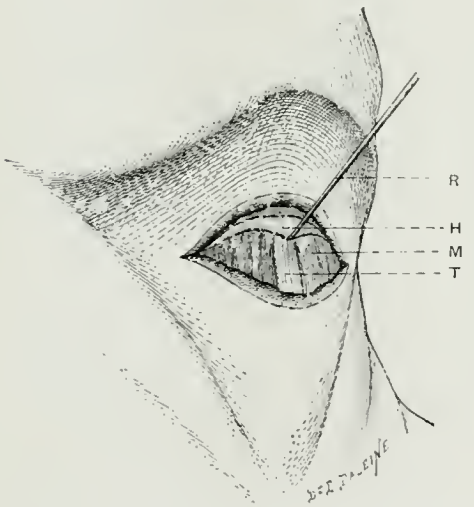


Fig. 163.—Subhyoid pharyngotomy. Skin and superficial planes divided. (H) Body of the hyoid bone. (M) Thyrohyoid muscle. (R) Hook drawing the hyoid bone upwards. (T) Thyrohyoid membrane.

Thyrotomy is particularly applicable in the case of foreign bodies lodged *within the glottis*. A vertical median incision is made, extending from a finger's breadth above the thyroid cartilage to the same distance below: the cartilage is then incised along its anterior angle, the middle line

[1] Vallas, of Lyons, has recommended trans-hyoid pharyngotomy, which comprises the following steps: median incision from the lower margin of the symphysis of the jaw down to the upper border of the thyroid cartilage—exposure of the hyoid bone and median division of the mylohyoid muscle—section of the hyoid bone and the thyrohyoid membrane in the middle line—lateral retraction of the two halves of the hyoid bone. A separation of 1½ ins. can be obtained.

being kept with the greatest possible precision; that is indeed the most delicate and important point in the operation; it is necessary to enter the laryngeal cavity exactly between the vocal cords, separating the anterior attachments from one another, without encroaching in any way on the cords; the section of the cartilage must therefore be made slowly and very carefully. The two alæ are then held apart by two small retractors or blunt hooks, or by the transverse interposition of the handle of the scalpel. The foreign body once removed, it suffices to let the two halves of the cartilage fall together, no direct sutures being necessary.

It is usually advisable to perform a preliminary tracheotomy before undertaking these operations, whether as primary or late procedures;

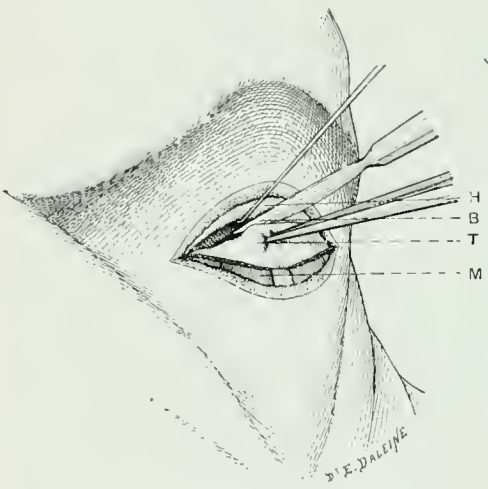


Fig. 164.—Subhyoid pharyngotomy. Incising the membrane. (B) Scalpel dividing the thyrohyoid membrane, which is raised by the dissecting forceps. (H) Hyoid bone. (M) Cut thyrohyoid muscle. (T) Thyrohyoid membrane.

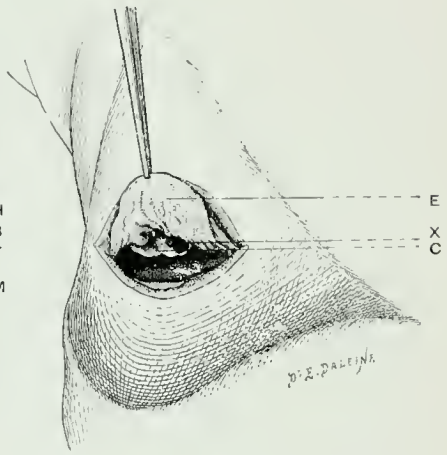


Fig. 165.—View of the superior laryngeal region after subhyoid pharyngotomy. (The head is thrown back and the operator stands behind). (C) Arytenoid cartilages. (E) Epiglottis turned forward and drawn out of the wound by dissecting forceps (the forceps may with advantage be replaced by a traction thread). (X) Foreign body in the ventricle.

a case recorded by L. Labbé [1] shows the dangers to which the patient may be subjected if this precaution is not taken. A metal star had lodged between the vocal cords in a young girl, and all attempts at direct extraction had failed; thyrotomy was therefore performed, the two segments of the cartilage were separated and the foreign body was removed without trouble; at that moment, however, a few drops of blood escaped into the trachea; a very serious attack of suffocation supervened, which necessitated immediate tracheotomy and artificial respiration. The child came round and ultimately recovered.

[1] L. Labbé. "La laryngotomie et la trachéotomie dans les cas de corps étrangers du larynx." *Congrès de chirurgie*, 1888.

Subglottic, Tracheal, or Bronchial Foreign Bodies.—The supra-glottic region has been explored with the finger and also by means of laryngoscopy. Nothing has been felt or seen. The foreign body is subglottic, tracheal, or bronchial.[1]

The famous inverted position with the head low is here even more irrational than in the previous class; the foreign body is projected against the glottis, produces spasm, and cannot escape; that is indeed the usual cause of the intermittent attacks of suffocation which occur in these cases; when such attacks come on, instead of placing the patient face down and head low, he ought to be seated upright and shaken, so as to dislodge the object from the glottis.

Spontaneous expulsion during a fit of coughing is possible, and various instances have shown that it may even occur at a late date; but when we also take into consideration the cases in which fatal complications have suddenly developed, sometimes a considerable time after the accident, we cannot avoid the conclusion that when the dyspnœa is severe or the suffocative attacks are repeated, immediate tracheotomy is urgently necessary. Even if there are no serious symptoms, if inspiration is easy, and there has been no repetition of the initial attack of dyspnœa, it is not advisable to depend on the chance of spontaneous expulsion, but, remembering the danger of sudden and perhaps nocturnal asphyxia,[2] to keep the patient under close observation, and make all the necessary arrangements for removal at the earliest possible date.[3] Killian's method of *tracheo-bronchoscopy* is indicated in these circumstances.

Whether this be practised, according to the nature of the case, by way of the tracheal wound after tracheotomy (inferior bronchoscopy), or by the mouth and larynx (superior bronchoscopy), it allows the foreign body so localized to be seized with special forceps, and to be removed either through the bronchoscopic tube or with the tube. The numerous satisfactory results which have been obtained by M. Killian and his followers.[4] and those which have been published in France by M. Guisez,[5] sufficiently prove the value of the method, which deserves to be much more widely employed than it is at present. Unfortunately, it requires a somewhat costly

[1] It is often mobile in the early stages. Some patients are perfectly well aware of the movements, which may further be indicated to the observer by fremitus felt on palpation, or by a whistling sound heard during inspiration on auscultation over the trachea.

[2] These sudden acute attacks may occur long after the entrance of the foreign body. In a case of Montaz an acute attack of suffocation occurred during the night seven months after a piece of copper had been "swallowed"; crico-tracheotomy was performed, and the obstruction was found embedded in the mucosa below the glottis and extracted. (Montaz, "Corps étranger de la trachée extrait par la trachéo-laryngotomie. *Bull. de la Soc. de chir.*, 1891, p. 372. Rapport de Routier.)

[3] Intubation has been followed by the spontaneous expulsion of the foreign body—for which it had made a way—in a case of Sevestre and Bonnus:—Girl of five years; a fragment of a glass bead lodged in the trachea: intubation: the bead was expelled during a fit of coughing. (*Soc. méd. des hôp.*, 29 oct., 1897.)

[4] See M. Hermann von Schrötter's book for a complete description of the method: "Klinik der Bronchoscopie." 1906.

[5] Guisez, "De l'œsophagoscopie et de la trachéo-bronchoscopie directes, en particulier, de l'extraction des corps étrangers des bronches par les voies naturelles." *Presse méd.*, 26 déc., 1903, p. 888. "Trachéo-bronchoscopie et œsophagoscopie, 1905." "Nos derniers cas de bronchoscopie et de l'œsophagoscopie. *Annales des maladies de l'oreille et du larynx*, déc., 1906. "Nouveaux faits de broncho-œsophagoscopie." *Ibid.*, 1908.

equipment, and, more important still, an amount of practice and training which are not generally available.

If bronchoscopy is impossible, tracheotomy remains as the sole resource. It happens quite often that as soon as the trachea is opened the foreign body is either expelled by a fit of coughing or it appears in the wound, when, if one is quick, it may be caught before it falls back again into the lower part of the trachea. At other times, on examining the interior of the trachea the foreign body may be seen below the glottis and made to descend by giving the larynx a sudden shake, or may be dislodged and extracted with forceps or a hook.

In other cases the tracheal mucous membrane may be stimulated so as to provoke coughing, the incision in the tube being kept open by means of a dilator or a couple of retractors; or the patient may be placed lying face downwards with the head low, and the chest be vigorously shaken. If results are still negative, the trachea may be left open and without a tube, the margins of the tracheal incision being fixed to the skin edges by one or two sutures on either side (*Fig.* 166). If it is impossible to keep the patient under constant observation, the cannula had better be left in position and again withdrawn prior to undertaking any further attempts at expulsion.

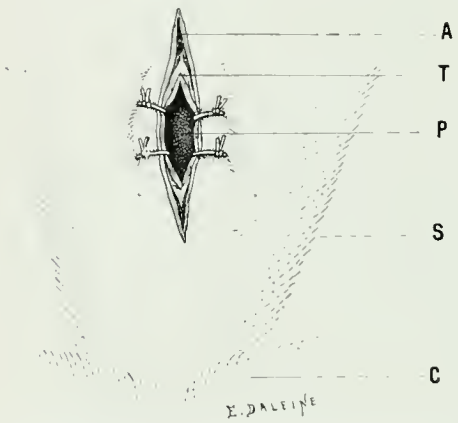


Fig. 166.—Temporary suture of the lips of the tracheal incision to the skin after tracheotomy for foreign body. (A) Skin incision. (T) Trachea. (P) Tracheal opening. (S) Prominence of the sternomastoid. (C) Clavicle.

Expulsion is not usually long delayed in cases where the tracheotomy has been done early;[1] when this has been delayed, however, the foreign body has had time to become fixed and is much more difficult to dislodge.[2]

[1] These tracheotomies performed for foreign bodies require so much more care because the air-passages have usually been irritated and eroded, and infection consequently finds a suitable soil in which to develop. Therefore, even if expulsion has been immediate, you will be well advised to resist the temptation to close the tracheal wound at once. Immediate closure has almost invariably ended in the wound having to be opened up again because of threatening asphyxial symptoms. A case reported by Pasteau and Vanverts ("Un cas de corps étranger dans la trachée chez un enfant de dix-huit mois; trachéotomie; guérison." *Bull. de la Soc. Anat.*, 1896, p. 38) :—The child was brought in a state of cyanosis: respiration was re-established by shaking it strongly: immediate tracheotomy: the foreign body was in the glottis: it was made to descend by shaking the child, and emerged from the tracheal incision: it was an orange pip. The trachea was closed by two catgut sutures passed through the perichondrium. Severe bronchopneumonia: trachea had to be re-opened. Ultimate recovery.

The tube should be left in position for some days, the neck and wound lightly covered with gauze; the patient should be kept absolutely quiet, in a room maintained at a uniform temperature: before removing the tube make sure that laryngeal respiration can be performed naturally. These precautions will have a considerable effect in diminishing the risk of secondary bronchopneumonia.

[2] In a child eight years old, operated on by d'Astros, a piece of bread-crust escaped from the tracheal wound on the eighth day. (*Rev. mens. des mal. de l'enfance*, nov., 1890.)

It is the same with a foreign body fixed in one of the bronchi; persistent and continuous dyspnœa and diminution of the respiratory murmur over one of the lungs indicate its presence;[1] most frequently it is the right bronchus which is affected. If the foreign body is of considerable size, or swells and obstructs the bronchial canal, the necessity for extraction becomes urgent.

Here again some satisfactory results of attempts at extraction through a tracheal wound with the aid of forceps, hooks, or magnets may be quoted;[2] all these attempts in the dark, uncontrolled by vision, are nevertheless both uncertain and dangerous.

TRACHEOTOMY AND INTUBATION OF THE LARYNX.

I.—TRACHEOTOMY.

Tracheotomy is the type of those urgent operations which every practitioner should be prepared to do at any time, in any place, and if necessary with extemporized instruments. Since the advent of the serum treatment of diphtheria, the indications have become much less frequent, but if less often required in cases of *diphtheritic laryngitis*, it is still urgently necessary for *injuries, burns, and foreign bodies in the larynx* (see preceding chapters); *in œdema of the glottis*, whether following an acute laryngitis, as in some cases described by Sestier,[3] or secondary to cancer of the tongue or tonsil, to retropharyngeal or tonsillar abscess, or to submaxillary cellulitis; *in tuberculosis* or *cancer of the larynx*, in which cases the necessity often arises very suddenly during the course of an unexpected attack of suffocation. There is no need for a detailed list: the indications can be summarized in two words, **laryngeal asphyxia.** In such circumstances operation is needed at once, and life or death frequently depends on **rapid decision and execution.**

To operate quickly is often essential for a successful tracheotomy; but in order to do this coolness and method are necessary. It is a mistake

[1] Of course a radiograph should always be taken, but as Guisez remarks, it is only of value when it gives a positive result.

[2] A child three years old had "swallowed" a pea: suffocation; spasmodic cough, which soon quieted down: nothing could be seen on laryngoscopic examination. During the night the respiratory difficulty increased. Next morning tracheotomy was performed, but no foreign body found. During the day the asphyxia became very marked; by auscultation it was discovered that the foreign body occupied and plugged the right bronchus. The pea, enlarged to three times its normal size, was removed from the bronchus by means of pharyngeal forceps passed down through the tracheal wound. Recovery in fourteen days. (J. Bondesen, "Om Fremmende Legemer i Luftrejem." *Hospitals Tidende*, 1890, Nos. 39, 40).

I may also relate an interesting case reported by Goullioud, of Lyons. An iron nail about two inches long had lodged in one of the first divisions of the right bronchus (radioscopy) in a child of twenty months; tracheotomy was performed, and through the tracheal opening the slender extremity of a strong electric magnet was introduced: the nail at once flew to the magnet, and was extracted. (*Soc. de chir. de Lyon*, 29 juin, 1900.)

[3] See a communication by Ch. Monod on acute primary œdema of the glottis during the discussion of a report by Du Cazal (*Bull. de la Soc. de chir.*, 1888, p. 297). These acute "idiopathic" œdemas of the larynx most often occur in persons in the prime of life, who after an exposure to cold, and usually during the night, are taken ill with sore throat and die suddenly in an attack of suffocation.

to say that tracheotomy is an operation which can be done in a trice; the statement may perhaps be correct in the case of operators who have had long special experience, former residents in a children's hospital for instance; but for the average practitioner, and even for the surgeon who only occasionally has to perform it, tracheotomy is always a delicate operation.

It is of the utmost importance to make out certain landmarks which are always easily recognizable, and then, without leaving the road thus mapped out, to follow the various steps of the operation boldly and unhesitatingly, but without haste.

The instruments required are a scalpel, some pairs of pressure-forceps, dissecting forceps, a trachea dilator, and a suitable cannula. A set of tracheotomy tubes is an essential item in the practitioner's equipment, and we may say that it is of very great advantage to have some tubes with the end shaped after Krishaber's pattern (*Fig.* 169). In an emergency a scalpel (or a penknife) and a tracheotomy tube will suffice.

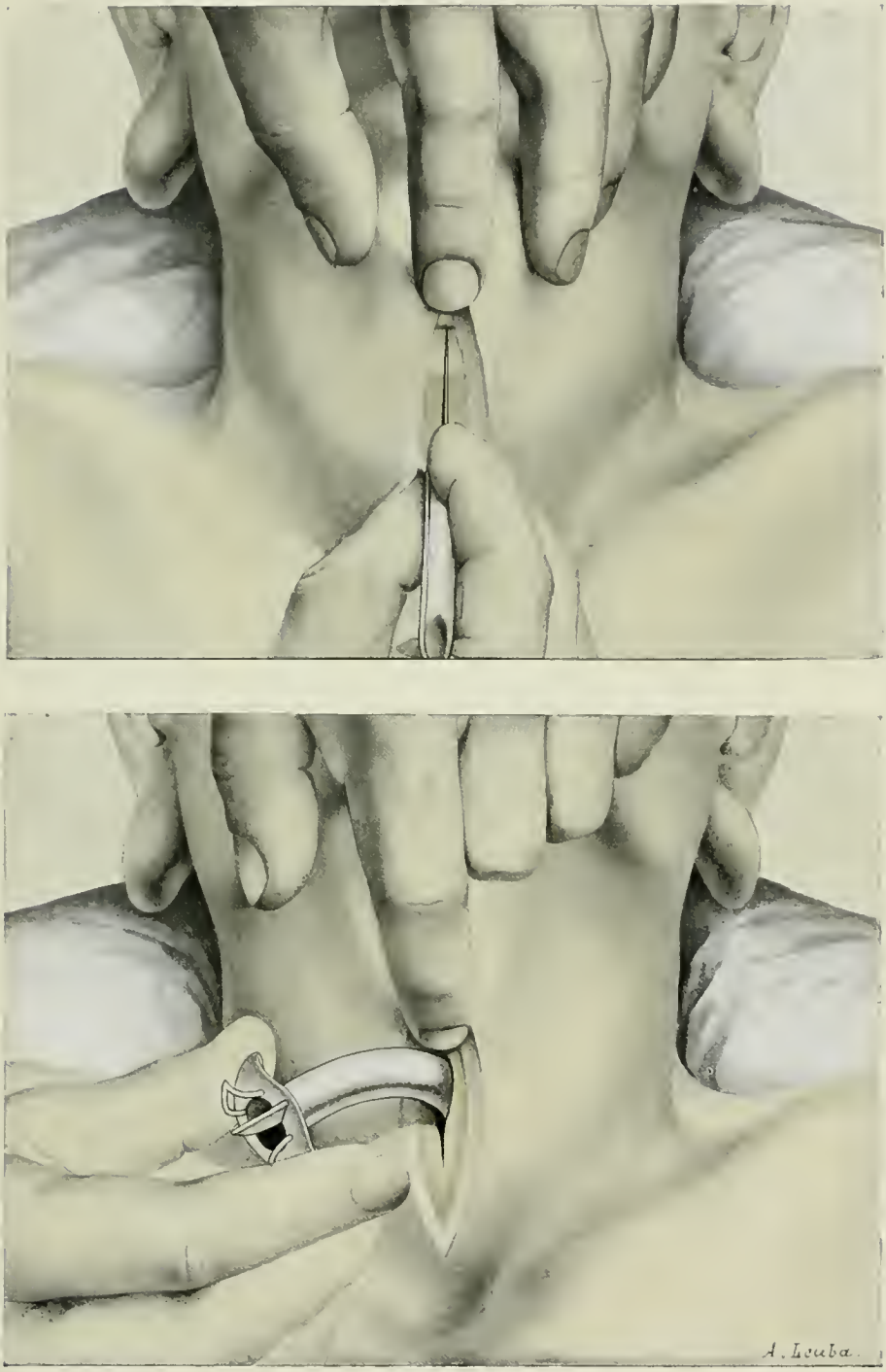
Tracheotomy.—The patient lies on his back with the shoulders raised by a cushion, the head moderately extended, resting on a hard pillow, and fixed by the two hands of an assistant.

If it is not an extremely urgent case, chloroform may be given drop by drop: when cautiously administered it is taken quite well, even in cases with serious respiratory trouble. When the case is urgent and suffocation threatens, no time must be spent over any preliminary preparations; *the vital necessity is to make an opening in the trachea and let the air enter at once.* Excluding, however, these extremely urgent conditions, it is to be remembered that by doing the operation cleanly, with sterilized instruments, and after disinfection of the anterior surface of the neck, the risks of local and broncho-pulmonary complications will be greatly lessened.

Survey the field of operation quickly; feel the hyoid bone, the prominent angle of the thyroid cartilage, the cricoid ring, and the suprasternal notch; estimate with the eye and the finger the distance which separates the cricoid from the sternum, and, by the very variable prominence of the upper end of the sternum, the *depth* at which the trachea lies. Sometimes the operation is on thin angular necks, where everything is in relief, where the landmarks, so to speak, spring forward under the eyes; more often, however, one has to do with the fat round neck and soft mobile trachea of a child; or it may be necessary to operate on an œdematous unrecognizable area, infiltrated with blood or air. Tracheotomy in the adult—especially in fat, congested, and choking adults—is sometimes a particularly difficult operation.

The middle line and the cricoid cartilage are the two best guides; the middle line is recognized by the eye, and the more accurately in proportion as the head is properly immobilized; the cricoid can always be felt.

Seize the cricoid with the fingers of the left hand, the thumb applied to its right side, the middle finger to the left; the tip of the index finger



TRACHEOTOMY

rests on the lower border of the cartilage and fixes it, "hooks it" if possible (*Fig.* 167). Once in position, this hand must not move until the trachea the opened, which should be a matter of a few moments only.

Incise the skin in the middle line with a narrow, sharp-pointed scalpel from immediately below the left index finger down to a finger's breadth above the sternal notch; deepen the incision steadily: proceed from end to end of the wound quickly, without stopping for the bleeding; slip the tip of the left index finger into the upper extremity of the wound so that it seizes the exposed cricoid cartilage, and using it as a guide, plunge the point of the knife vertically into the trachea (*Plate III*), making the point penetrate to a depth of about a quarter of an inch. The wall of the trachea being tense and possessing a certain amount of resistance, a little firmness is necessary in making the puncture: but it must also be made carefully, because one may very easily pierce the tube and push the point of the knife through the posterior or lateral wall. A whistling noise indicates that the trachea is opened. Enlarge the opening by cutting downwards through one, two, or three of the tracheal rings: the sensation felt in cutting through a ring allows the number cut to be easily appreciated.

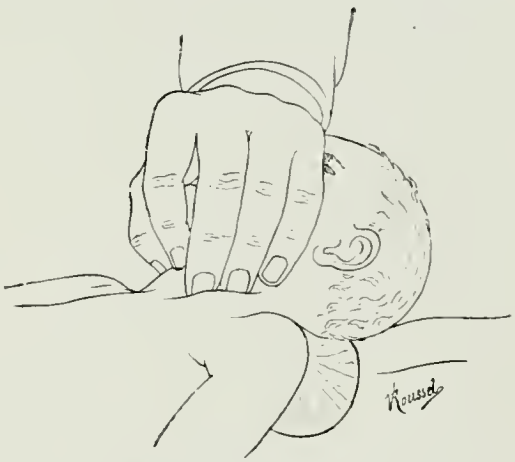


Fig. 167.—Seeking the landmarks and fixation of the larynx.[1]

The incision being made, air mixed with blood bubbles out into the wound. Be careful not to change the position of the left hand, but slip the index finger into the tracheal slit, and on it at once introduce the tube. Do this from the side, transversely, in just the same way as a catheter is passed: insinuate the tip under the left lip of the tracheal incision (*Plate III*), and when it has entered rotate the other end downwards and inwards towards the middle line and raise it gently, at the same time pushing the tube into the trachea.

The stage of introduction is greatly facilitated by the use of Krishaber's tubes. The conical extremity separates the borders of the tracheal wound and enters without any difficulty. In all cases be careful not to use too

[1] *Fig.* 167 is from Sevestre and Martin's article: "Diphtérie," *Traité des maladies de l'enfance*, t. i.

Plate III.—The upper figure illustrates the puncture and incision of the trachea; the lower one, the introduction of the tracheal tube.

large a tube, which will only enter with difficulty, and when introduced may erode and ulcerate the posterior wall of the trachea.

The introduction of the tube is perhaps the most troublesome step in the whole operation. To do it well and quickly, the operator must not be too precipitate, nor seek to introduce the tube until the way for it has been properly prepared; if one nervously tries to raise the outer end of the tube before the inner extremity has passed through the tracheal opening, the latter slips into the cellular tissue outside the trachea, and the whole movement has to be gone over again.

As soon as the tube is properly in place, air passes in and out with a noise which is unmistakable; now is the time for raising the patient into the sitting position, making him cough and respire deeply, and for putting in practice, if necessary, the various procedures which we shall presently mention.

Introduction is usually most easily and expeditiously performed when one is able to do it without a dilator. This instrument is, however, particularly useful in extremely urgent cases where the patient has stopped breathing, and where it is necessary to admit air and to empty the bronchi at once. As soon as the tracheal incision has been made, the curved tracheal branches of the closed instrument are introduced, the handle is raised and the instrument opened, while the head is extended, and artificial respiration is begun. When natural respiration is assured, the tracheal tube will be slipped, convex side upwards, into the gap between the blades of the dilator, and by raising the outer end made to slip into the trachea: it is then fixed by one hand while the dilator is withdrawn with the other.

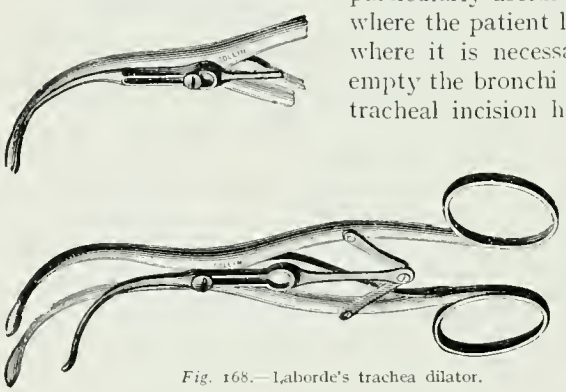


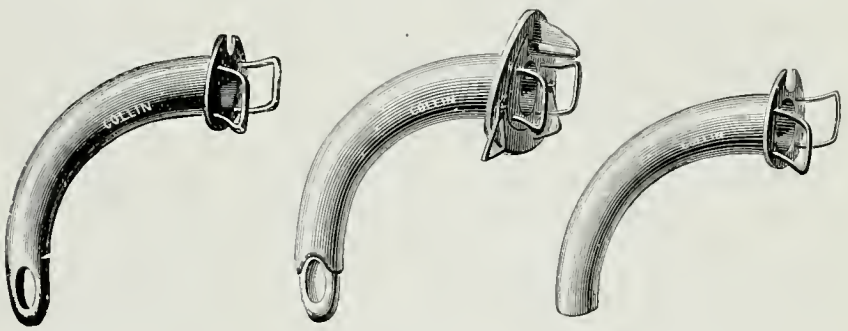
Fig. 168.—Laborde's trachea dilator.

In the adult, and in old people when the neck is much congested and covered with enlarged veins, and perhaps with a large thyroid gland, or when the patient is in such a condition of anæmia or collapse that it is all-important to avoid any loss of blood, the operation may be performed with the thermo-cautery. With the knife at a red heat, the skin is incised, and the subcutaneous layers of tissue divided down to the trachea, which is then punctured with the scalpel. It is quite evident that it may often be of very great advantage to carry out the operation in this manner; apart from the avoidance of loss of blood, the dry wound enables the operator to see clearly what he is doing; the great disadvantage of the method is that it takes a long time and consequently is impracticable in an urgent case. Besides, it is well to know that the best means of sparing

blood in a tracheotomy is to do it quickly and methodically: rapid introduction of the tube is the best hæmostatic. Apart from certain abnormalities which are too uncommon to require consideration, the bleeding is venous, due to the respiratory difficulty, and speedily ceases when the dyspnœa and venous congestion have been overcome.

The risk of bleeding is only serious in the lower part of the neck above the sternal notch, if any slip should occur in handling the knife there; the danger is somewhat accentuated by the extended position of the head, which brings the innominate artery above the sternum. This is a weighty reason for preferring high tracheotomy or cricotracheotomy to the low operation below the thyroid isthmus.

Cricotracheotomy (*Fig.* 158) is a very simple operation, and consists in thrusting the point of the knife into the cricothyroid space, which is usually quite definite and easily accessible, just above the cricoid cartilage, and then continuing the incision downwards in the middle line, dividing the cricoid ring and the two upper rings of the trachea. It is only



Inner tube. Complete cannula. Outer tube.

Fig. 169.—Krishaber's tracheotomy cannula.

feasible if the cricoid cartilage is not so much ossified as to render its division difficult or impossible; it is therefore not always practicable after a certain age. However, it is usually possible to determine beforehand, in a great measure, the condition of the cartilage. On a swollen neck the operation is sometimes of the greatest value.

Intercricothyroid Laryngotomy.—This is, at least in the adult, an excellent operation which is too little known and too seldom practised.[1] It is extremely simple, it exposes the patient to no risk of hæmorrhage—indeed there is hardly any bleeding at all; and the landmarks are always easily recognizable.

It is true that it requires for its proper performance a special cannula with Krishaber's tip, but as we have already said, this tube ought to be

[1] Richelot, "Laryngotomie inter-crico-thyroïdienne." *Bull. de la Soc. de chir.*, 24 mars, 1886, p. 221, and *Acad. de méd.*, 21 avril, 1896.

included in the ordinary tracheotomy set. A cannula 9 mm. in diameter is as a rule the most convenient size.

Without going into details of comparatively little practical interest, the following average measurements of **the cricothyroid space** should be kept in mind: In a child of 10 or 11 years the space measures vertically 6 to 7 mm.; in the adult female, 8 to 10 mm.; in the adult male, 9 to 11 mm.

Intercricothyroid laryngotomy is therefore applicable in the adult, in which case it is easily performed, and it is the more valuable because there is nothing to prevent, if necessary, incising or excising the upper border of the cricoid cartilage.

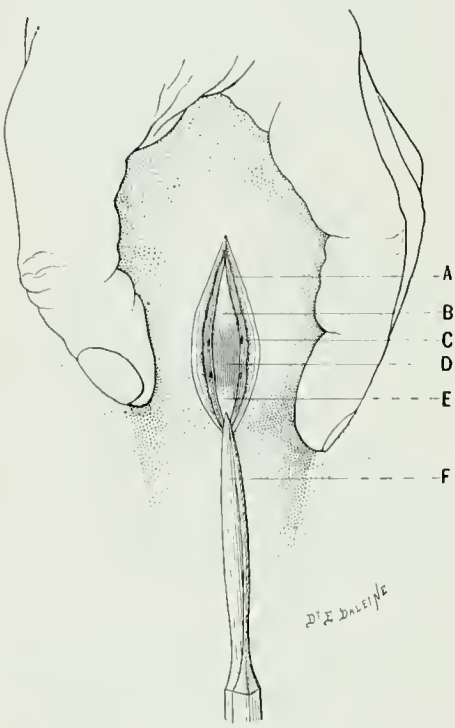


Fig. 170.—Intercricothyroid laryngotomy (1st stage). (A) Incision. (B) Thyroid cartilage. (C) Artery. (D) Cricothyroid membrane. (E) Cricoid cartilage. (F) Scalpel, making the incision right down to the membrane at the first cut.

The head being fixed in extension and the neck well exposed, feel the pomum Adami, carry the finger down the anterior angle of the thyroid cartilage, and mark its lower border, the cricothyroid space, and the upper border of the cricoid cartilage. Then applying the left index finger in such a manner as to mark and raise the lower border of the thyroid cartilage, make a median incision in the skin about an inch long from the tip of the finger downwards (*Fig.* 170), cut straight down to the membrane at once, puncture it with the knife held vertically, and divide it in its whole vertical extent (*Fig.* 171). In withdrawing the knife, incline the cutting edge first to the right, then to the left, so as to nick the membrane transversely and so widen the opening. All this can be done very quickly, because there is nothing to fear and nothing to avoid; and if the case is urgent and time presses, one may stab right through skin and membrane, and at one stroke open a passage for the air.

Then take Krishaber's cannula (*Fig.* 169), and slip the rounded tip into the opening in the membrane; the base of the tube being raised, the introduction is completed without any trouble. The manœuvre is particularly simple, because the upper border of the cricoid cartilage serves as a point of support around which the curved tube glides.

The only difficulty which may be met with is due to unusual narrowness of the space. In such a case all that is necessary to provide free access is to excise a segment of the upper border of the cricoid or to divide the cartilage vertically.

To summarize : in opening the cricothyroid space one need not worry about the venous plexus, nor the isthmus of the thyroid gland, nor the depth of the trachea ; the operation is certainly within the powers of anyone.

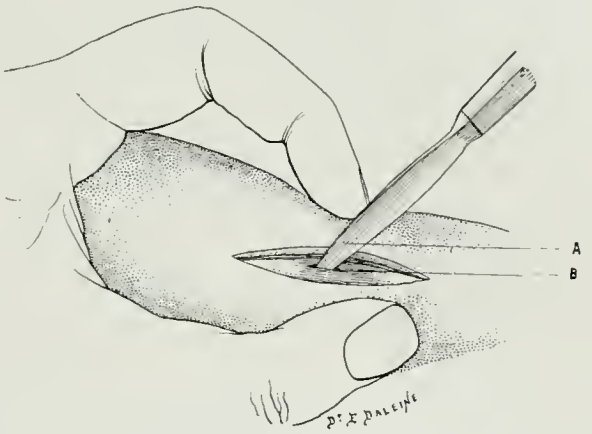


Fig. 171.—Intercricothyroid laryngotomy (2nd stage). (A) Scalpel puncturing the cricothyroid membrane. (B) Cricothyroid membrane.

Of course, intercricothyroid laryngotomy is not applicable to cases where an obstacle is situated in the trachea ; it gives less room perhaps, and is inferior to cricotracheotomy or high tracheotomy when there is a possibility of subsequent intratracheal manipulations being required, in the extraction of a foreign body for example ; but in cases of asphyxia of true laryngeal origin, or in œdema of the glottis, it ought to be the operation of choice.[1]

II.—INTUBATION.

Intubation cannot be improvised : it requires special instruments, a certain degree of practice, and further, during the time the tube is in the throat, *constant medical supervision* of the patient. Therefore it is

[1] A few words with regard to the treatment after tracheotomy or one of the similar operations : once the tube is in position it is fixed by tying round the neck two tapes which are attached to the eyelets ; the only dressing required is a layer of moist gauze around the neck and tube. The inner tube is withdrawn and cleaned as soon as it shows signs of becoming obstructed (every three or four hours as a rule) ; the outer tube must be changed every day in a child, every two or three days in an adult, to prevent tracheal ulceration and secondary hæmorrhage ; it is re-introduced in the manner already described. Dilating forceps are not usually necessary, as the track remains patent.

Before permanently removing the tube one must be repeatedly assured, by taking out the tube and occluding the tracheal opening with the finger, that laryngeal respiration is properly established. A very close watch must be kept over the patient during the first hours or the first day, so that the tube may be re-introduced at once if any symptom of spasmodic dyspnœa appears. The wound is simply dressed, without any attempt at bringing the margins together, and heals readily.

impossible to describe it as a method of treatment of general application ; but it is highly desirable that it should become so. It is indeed in certain conditions the natural complement of the serum treatment of diphtheria. The very real dangers and difficulties of tracheotomy constitute a sufficient reason for substituting this simple bloodless procedure whenever possible. On these grounds intubation must be included here, and we are indebted for the necessary description to Sevestre's masterly account of the subject.

Intubation is performed by touch, and almost invariably without the help of vision ; it is the finger alone which finds the landmarks, guides the tube, and places it in the proper position ; it is therefore necessary as a preliminary to teach the finger to recognize the epiglottis, the arytenoid cartilages, and the laryngeal entrance in children of all ages.

Shortly, the method is as follows. The mouth being fixed open, the left index finger is introduced, finds the entrance to the larynx, and is then applied to the posterior surface of the epiglottis ; along this finger as a guide, the tube, mounted on a special curved instrument, is carried ; it is introduced into the laryngeal opening, disengaged from the introducer, and buried in the cavity of the larynx. Once properly introduced, it holds in place because of its length and shape, its enlarged portion lodging below the cricoid ring, and the funnel-shaped upper extremity resting on the aryteno-epiglottidean folds.

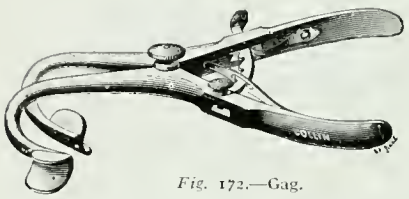


Fig. 172.—Gag.

The following are the **indispensable instruments**:[1] (1) *a gag* (*Fig.* 172) ; (2) *an introducer* (Collin's)—the use of this instrument is sufficiently explained by *Figs.* 174 and 175 ; (3) *a laryngeal tube* of appropriate length and calibre. The short tubes of Bayeux or Sevestre are those most commonly employed ; they go down to the third ring of the trachea, not so far as the longer tubes of O'Dwyer (*Fig.* 173). A graduated scale enables the operator to choose with sufficient exactitude a tube adapted to the age of the patient ; it is well also to have ready the tubes immediately larger and smaller than the chosen one, so as to be prepared for any possible abnormality. A silk thread is passed through the flanged upper end of the tube, by means of which the latter may be withdrawn if necessary during the attempts at introduction.

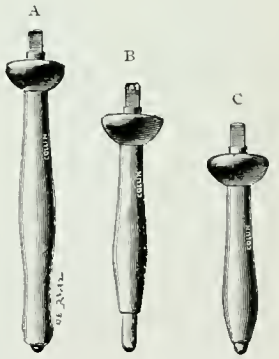


Fig. 173.—Laryngeal tubes.
(A) O'Dwyer's tube. (B) Bayeux's short tube. (C) Sevestre's short tube.

[1] Limiting ourselves here to a general account of the technique of intubation, we can merely mention M. Froin's laryngeal tubes and MM. Deguy and Weill's apparatus.

The child is held between the legs of a seated assistant, who wraps his arms around the little patient and presses him against his chest; a second assistant standing behind fixes the head between his two hands, holding it slightly flexed. The sterilized instruments, with the tube adapted to the introducer and provided with its thread, are placed within easy reach of the operator, who seats himself in front of the child and places the gag in position; a third assistant takes charge of this.

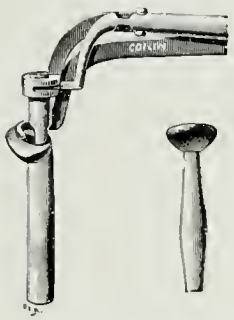


Fig. 174.—Collin's introducer at the moment when the tube is being pushed off the obturator.

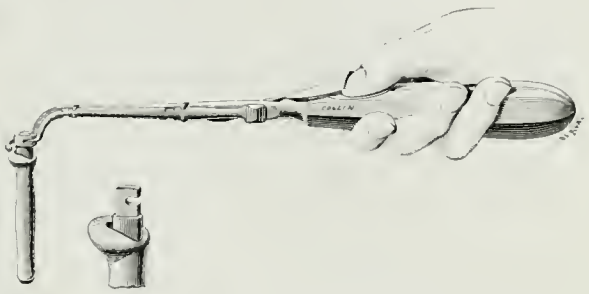


Fig. 175.—Collin's introducer.

Carry the left index finger to the back of the pharynx, then bring it gently forward to the base of the tongue, recognize the epiglottis and the arytenoid cartilages, and note the form and variable width of the laryngeal orifice.

Keep the left index in position on the posterior face of the epiglottis (*Fig.* 177) at the entrance of the larynx and, taking the introducer armed with the tube in the right hand, carry it straight to the back of the pharynx (*Fig.* 178); then draw it back a little, keeping very exactly in the middle

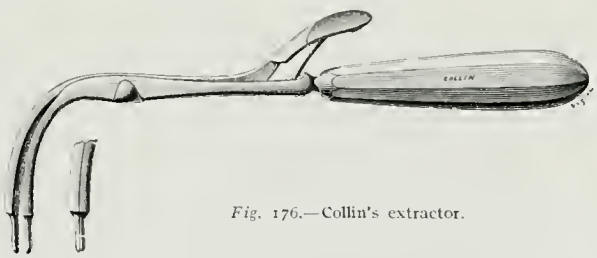


Fig. 176.—Collin's extractor.

line, till the tube comes against the ungual surface of the index finger; now slip the tube round the outer border of the finger (*Fig.* 179) and place it between the palmar surface of the finger and the epiglottis.

The tube is now suspended over the glottis: introduce it gently (*Fig.* 180) by raising the handle of the introducer a little, keeping strictly to the middle line (between the two upper median incisors).

Make sure, before going any further, that it is **really in the larynx,** by feeling for the *membranous bridge* which stretches between the two

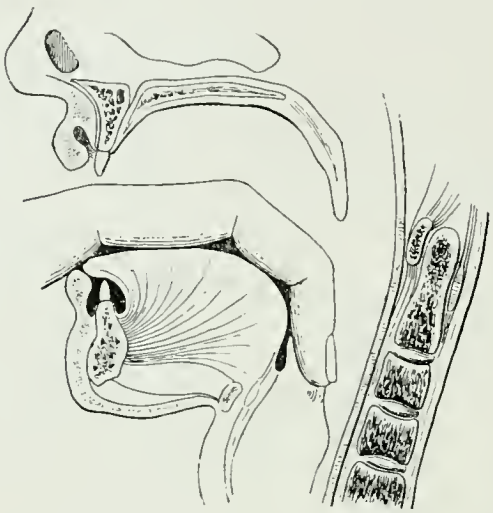


Fig. 177.—Left index finger fixing the larynx.[1]

arytenoid cartilages and which must lie behind the tube. This is done by passing the left index finger down along the posterior aspect of the tube. The tube is felt quite distinctly at first, but if it has properly entered into

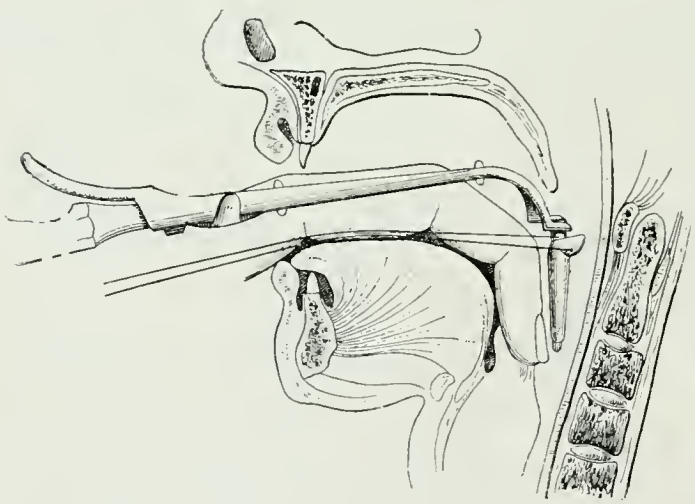


Fig. 178.—The tube is pushed first of all to the back of the pharynx.

[1] *Figs.* 172 to 185 are from Sevestre and Martin's article: "Diphtérie." *Traité des maladies de l'enfance*, t. i."

the larynx there comes a point where its lower part is only felt through the tense musculo-membranous band stretching between the two arytenoids (*Fig.* 181). Once the exploring finger has definitely felt the tube lying

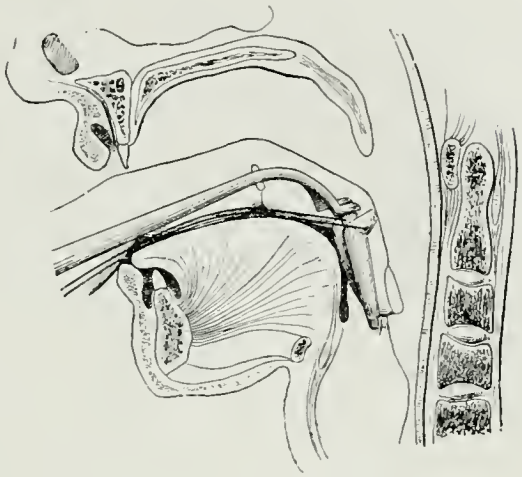


Fig. 179.—The tube slipping round the outer border of the left index finger.

below this membranous bridge the operator may be sure that the tube is actually in the larynx.

Now fix the tube with the left index finger, placed as in *Fig.* 182, which

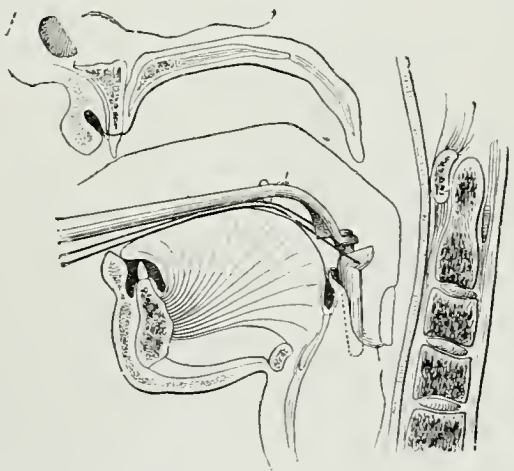


Fig. 180.—The tube has reached the front of the finger and is now passing into the larynx.

steadies it and pushes it in, while the right hand disengages and withdraws the introducer. The pushing in of the tube must never be done violently, but requires a certain amount of firm pressure to overcome the laryngeal

spasm, which is often great. The index finger completes the introduction of the tube (*Fig.* 183), now free, until it has—excepting the flanged upper

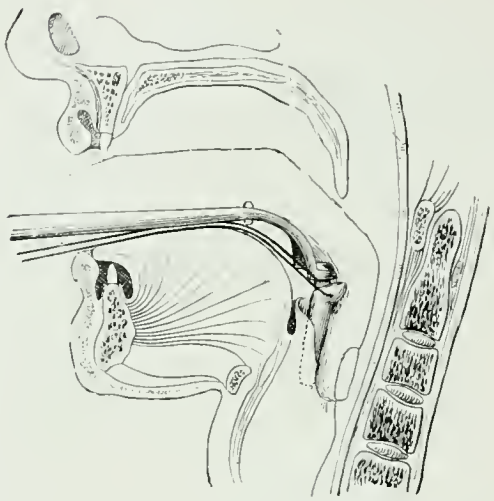


Fig. 181.—Feeling for the membranous bridge.

end—disappeared into the larynx (*Fig.* 184). A peculiar sound indicates the passage of air through the metal tube; once respiration is properly established, the thread is withdrawn[1], one of the ends being first cut short

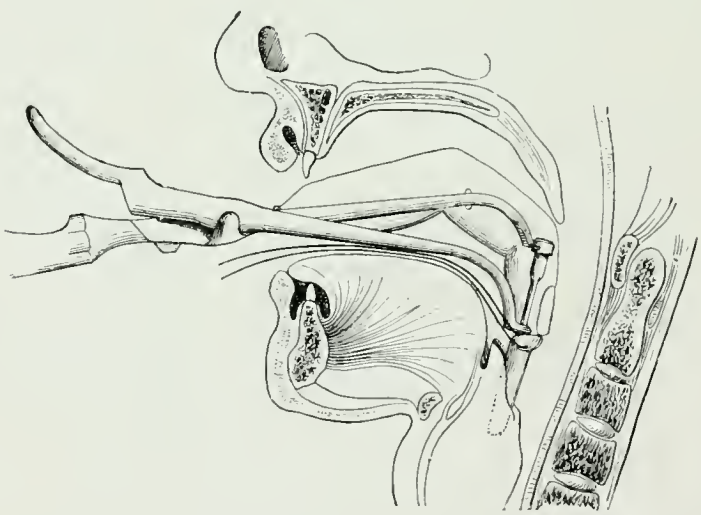


Fig. 182.—The obturator is withdrawn while the index finger fixes the tube.

[1] The usual English practice is to leave the thread in position and attach it to one of the teeth or to the skin of the face with sticking plaster: this facilitates the removal of the tube, and prevents it being swallowed or slipping into the trachea. (Translator).

and the head of the tube fixed by the index finger (*Fig.* 185). The gag is then removed and the operation is finished.

Such is the technique in its various stages, and the accompanying

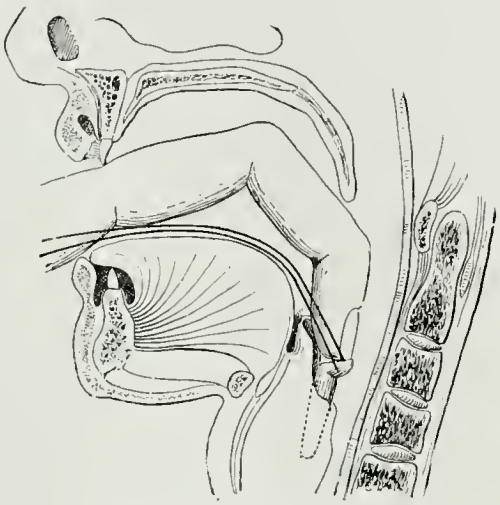


Fig. 183.—The index finger completes the descent of the tube into the larynx.

figures, borrowed from Sevestre and Martin's article, will enable the description to be very readily followed. It must be said, however, that

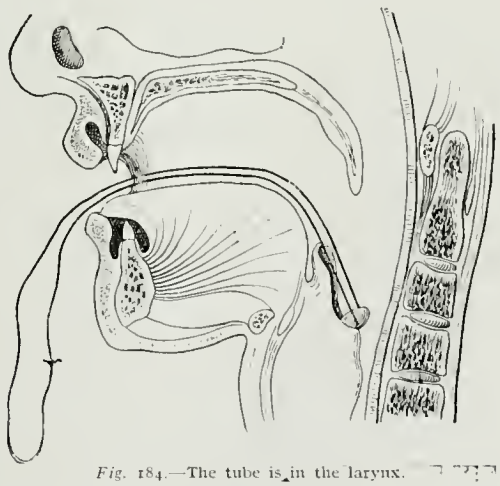


Fig. 184.—The tube is in the larynx.

the practical application is by no means so easy as the description might lead one to suppose, particularly in inexperienced hands.

Without speaking of the difficulties which are sometimes experienced

in putting the gag in position, the entrance to the larynx is difficult to recognize and to reach in certain conditions.

The epiglottis is sometimes soft and difficult of recognition in very young children, in whom also the narrowness of the mouth adds to the trouble; at seven or eight years of age the larynx is rather low and not easily reached; it is necessary to know how to immobilize the epiglottis. When there is much laryngeal spasm the exploring finger encounters a sort of ball, on which it is almost impossible to find an opening; and in any case, if the opening were found, it would be under these circumstances too small to allow the tube to enter. What is to be done? Never try to pass the tube forcibly and by chance. With the tip of the left index finger close the

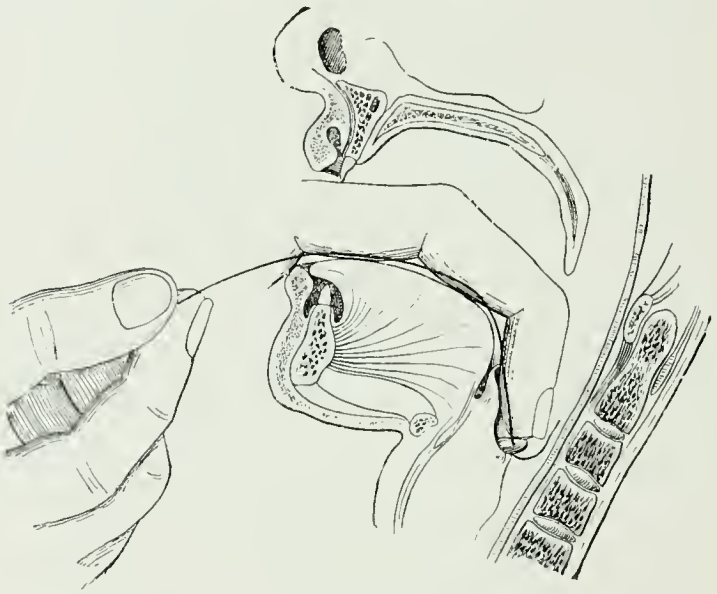


Fig. 185.—Withdrawing the thread.

glottis for a few moments. The little patient, irritated by this manœuvre, makes violent efforts at respiration. Then the finger is suddenly removed; the child now takes a deep inspiration, his glottis opens, and, if one is quick, advantage may be taken of the opening to introduce the tube.

During the attempts at introduction, the tube may slip off the obturator; it may be badly placed and get into one of the pre-epiglottidean fossæ, or into the œsophagus, or even—though that could only happen if unjustifiable force were employed—make a false passage in the ventricle or through the cricothyroid membrane. The thread then serves to extract it, and another attempt can be made.

Once in position, the tube may give rise to various troubles; it may be expelled by the mouth in a fit of coughing, or may fall into the œsophagus and be swallowed; it may be plugged by false membrane or mucus; the sudden obstruction which sometimes comes on immediately

after the introduction of the tube renders its instant removal necessary to save the patient from suffocation. More slowly developing respiratory obstruction sometimes yields to an injection of menthol oil; if not, it also renders rapid detubation necessary.

These are the accidents, always possible after intubation, which render the lack of competent surveillance by a medical practitioner or a person accustomed to the operation so dangerous.

For extracting the tube, special instruments are provided (see *Fig.* 176). Bayeux has, however, introduced an ingenious procedure which very greatly simplifies the task. He enucleates the tube, by combining pressure exercised on the trachea below the cricoid cartilage with forward inclination of the head.

"The nurse charged with the enucleation is seated opposite the child, whose head she holds with one hand in such a manner that the fingers are on the occiput and the thumb is in front on the forehead. The other hand encircles the patient's neck, the ball of the thumb being applied to the lower border of the cricoid cartilage, behind which the lower end of the tube lies. The operator draws the child's trunk towards himself, so that it makes approximately an angle of 45 degrees with the horizontal plane; the head being fixed, it is naturally strongly extended by this movement.

"The nurse then, with the thumb which is applied to the trachea, makes moderate but persistent pressure on it until the intralaryngeal tube is felt to slip away; the hand applied to the child's head immediately depresses it, so that the face is directed towards the floor. At the same moment the child is told to spit, and almost invariably the tube is expelled from the mouth."

Generally speaking the tube should be removed on the second or third day from diphtheria patients who have been treated with serum; it is, however, impossible to lay down a definite rule. The larynx must be free, with no threatening of glottic spasm. The latter condition may render it difficult to leave out the tube, and in patients who have been intubated, as in those who have been tracheotomized, the laryngeal or tracheal tube may have to be hastily replaced.

FOREIGN BODIES IN THE PHARYNX AND ŒSOPHAGUS.

These are seen particularly in children, and are as varied as the foreign bodies in the air-passages: bits of bone, coins, buttons, thimbles, pebbles, even keys, are seen; in adults tooth plates are perhaps the most common.[1]

The best practical classification of these bodies is based on their *size*, *shape*, and *superficial characters*; in other words, on the characteristics

[1]According to Egloff dental plates constitute 35 per cent of the foreign bodies removed by external œsophagotomy since 1856. ("Ueber die Entfernung von Fremdkörpern aus der Speiseröhre, insbesondere durch die Œsophagotomia Externa." *Beitr. zur klin. Chir.*, 1894, Bd. xii., III, p. 142).

which determine or modify the facility with which they may be expelled, extracted, or pushed down. Large flat objects, coins for instance, when lying transversely in the canal, produce mechanical effects similar to those caused by such solid masses as pieces of bone, balls, or large imperfectly masticated lumps of food, which plug the lumen of the canal and at the same time compress the larynx or trachea. Sharp and angular bodies may catch in and wound the wall, and often cause serious local lesions, with rapidly developing complications that necessitate early operative removal of the offending object, if careful attempts at extraction by way of the mouth have failed.

Expulsion by the mouth, propulsion into the stomach, and extraction by the mouth, represent the methods of choice; **external œsophagotomy** should only be undertaken as a last resource; in certain conditions, however, it becomes absolutely necessary.

Two classes of these cases must be distinguished: (1) When the doctor is present or is called in immediately after the accident; (2) Where the accident has occurred one, two, or more days before he sees the patient.

I.—THE FOREIGN BODY HAS JUST BEEN SWALLOWED.

In these cases the child is suffocating, he throws himself back, his mouth is widely open, the eyes protrude, and the face is congested. Carry the finger at once to the back of the mouth, into the pharynx, to the back of the epiglottis; perhaps the obstacle may be felt, and by a rapid movement be dislodged and extracted.

If nothing is found, or if though felt it is not possible at once to remove the obstruction, and respiration has almost or entirely ceased, do not persist, nor waste time by placing the patient's head low or in shaking his chest; **suffocation is imminent; therefore open the trachea.** It has happened, after the performance of this vitally important step, that the foreign body has been spontaneously expelled by coughing or vomiting.

Excluding these extremely urgent cases, the first duty of the practitioner is *to assure himself of the presence of the foreign body*, and then *to determine its position*. Neither the history, the striking initial symptoms, nor the patient's sensations, are absolutely certain guides; it is well to be sceptical and only to base conclusions on the positive results of an examination.

Kronlein[1] has related the case of an old deaconess who, after an epileptic fit, discovered that her tooth-plate was no longer in her mouth, and in great fear, concluded that she had swallowed it; she said she felt it quite definitely a little above the stomach, at which position she felt pain in swallowing. Kronlein explored the œsophagus and felt a sensation

[1] Egloff, *loc. cit.*, p. 176.

of resistance a little above the cardiac orifice of the stomach. However, before going any further, he had a careful search made in the patient's room, *where finally the lost tooth-plate was discovered behind the foot of a chest of drawers*. A lady was sent to me some years ago to have a needle, which she had swallowed two days previously, removed; she felt it very distinctly about the middle of the neck, and always indicated the same point as the seat of the pain: she swallowed with difficulty. Exploration gave negative results, and a radiograph showed not the slightest trace of a needle. The patient returned two months later; the pain, and difficulty in swallowing had continued, and she was in a condition of steadily increasing anxiety. Another radiographic examination was required before she could be convinced of the total absence of any foreign body from the pharynx or œsophagus.

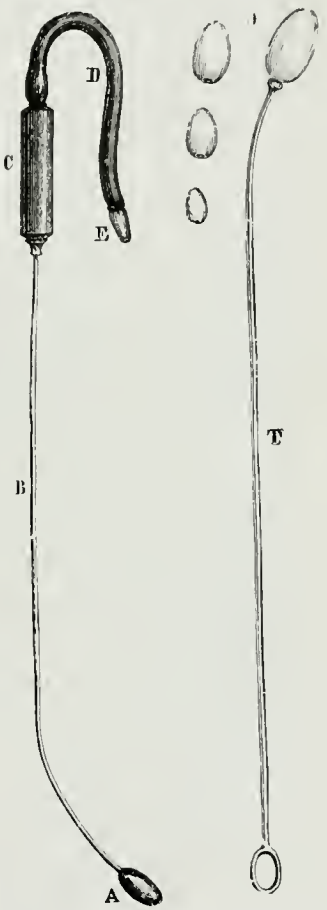


Fig. 186 *Fig.* 187.

Fig. 186.—Resonating instrument for detecting the presence of foreign bodies in the œsophagus (S. Duplay.) (A) Hollow olive tip. (B) Flexible metal shaft. (C) Resonating cylinder. (D) Rubber tube. (E) Earpiece.

Fig. 187.—Olive-ended sound.

Make the patient open his mouth widely, and with a good light examine the back of the pharynx, the tonsils and the pillars of the fauces (where fish-bones are often implanted), and the soft palate; then carry the index finger behind the base of the tongue and investigate the lower segment of the pharynx down to the level of the cricoid cartilage; if nothing is found, turn the finger upwards, slip it behind the soft palate, and explore the nasopharynx.

If still unsuccessful, palpate the neck along the anterior border of the sterno-mastoid, particularly on the left side, where the œsophagus is most accessible, and in such a manner that the fingers are pushed down on either side of the trachea, into contact with the vertebral column. Do not expect to get a definite sensation or to make out definite outlines even if a foreign body is present; usually, if anything is detected, it will be only an ill-defined sense of resistance; the indication is none the less important, and becomes particularly valuable if confirmed by the introduction of an œsophageal bougie (*Fig.* 188).

The instrument of choice for intra-œsophageal exploration is the resonating sound (*Fig.* 186), or in default of it, a sound fitted with a

small-sized olive-shaped end (*Fig.* 187); the blow of the metal or ivory against a hard foreign body, itself often metallic, gives very useful information. If nothing but an ordinary œsophageal sound is available, it will do very well if properly used; it will give the impression of being checked, of obstruction more or less complete, or the sensation of rubbing over a more or less irregular surface, if the calibre of the gullet is not completely obstructed and the instrument can pass the obstacle.

The manœuvre must be carried out with the greatest gentleness: this is the only way to get useful information as to the state of affairs without incurring the risk of pushing farther in, and perhaps impacting, a foreign body which was originally well situated for removal.

Fig. 188.—Search for and extraction of a foreign body in the œsophagus.

We need only mention *radiography*, which may be of the greatest service if a suitable installation is available. Unfortunately it is not usually at hand, and must be dispensed with.

The results of this *preliminary exploration*, if they do not simplify the task of extraction, at least enable it to be conducted methodically.

Extraction should be immediately undertaken by means of rational mechanical measures, without spending time in administering emetics, which are often dangerous, or in trying various positions or shakings, which are almost always useless.

If the foreign body has been detected in the pharynx, it may usually be extracted with the finger or curved forceps—polypus forceps for example—or by means of an improvised hook.

There are two different ways of working. If dealing with an adult or a child of suitable age, the patient should be seated in front of the operator, who, with the jaws separated by a gag, the handle of

a spoon, or a wooden wedge, carries his index finger quickly to the back of the pharynx, dislodges the foreign body, and directs it towards the mouth, at the same time inclining the patient's head forwards; if the object slips away from the finger while it is being guided towards the mouth, the finger is withdrawn quickly and the gag removed from between the jaws, when the patient will in all probability be able to rid himself of it.

In the case of a very young child, or if it is necessary to use an instrument, the patient should be placed on his back with the head hanging over the edge of the bed or table: in that position all danger to the larynx is avoided. If the coin or button, etc., slips from between the jaws of the forceps, it will fall into the naso-pharynx and not into the glottis.

Foreign bodies situated in the nasopharynx are best dealt with by way of the nose; a pair of dressing forceps or a director passed gently backwards along the floor of one or the other inferior meatus will cause the obstacle to be dislodged and to fall to the back of the mouth, where the left index-finger will await it and direct it outwards.

Sometimes the same result may be attained, and with less risk of injury, by means of a large injection directed along the floor of the nasal fossa; it will be wise therefore always to commence with this harmless procedure. Where it is possible to control the extraction by pharyngeal illumination with the mirror, this will be preferable to blind attempts with the finger alone.

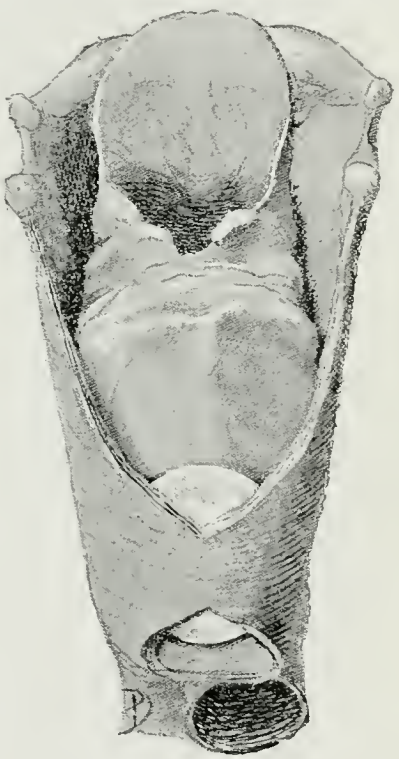


Fig. 189.—Foreign body in the œsophagus (Delbet).

The removal of foreign bodies from the **œsophagus** is as a general rule much more difficult. In children it is always advisable to try first of all an ingenious method recommended by M. Félizet: "We employ a urethral coudé catheter No. 18 (French scale). Once the instrument has come in contact with the foreign body, we communicate a rotary movement to it, so insinuating it spirally past the obstacle into the stomach. We then, varying the quantity according to the age of the child, inject from half a pint to a pint and a half of tepid boracic lotion into the stomach and gently withdraw the catheter. In returning, the bent end of the instrument catches at the coin, whilst we continue our irrigation until vomiting occurs and disengages the foreign

body, which is then brought up with remarkable facility, attached to the end of the catheter."

Instrumental extraction must always be carried out with great caution. Amongst the various forms of forceps, hooks, and extractors in use, we shall only mention *Kirmisson's œsophageal crotchet* (*Fig.* 190), which should in ordinary practice replace *v. Graefe's coin-catcher* (*Fig.* 191), and two forms of *œsophageal forceps* (*Figs.* 194 and 195).

Fig. 190. *Fig.* 191.

Fig. 190.—Kirmisson's œsophageal crotchet.

Fig. 191.—Von Graefe's coin-catcher.

For removing coins, the crotchet is the most suitable instrument. The coin-catcher can be useful in experienced hands if employed methodically, gently, and without haste; if these conditions are not observed, it is too dangerous, and I should not recommend it to any isolated practitioner who has had no previous experience with it.

Its introduction is, as a general thing, quite easy, but it is the extraction which causes trouble, because from its shape and mobility it readily catches the œsophageal wall, or hooks in the cricoid cartilage, which may easily be badly torn; indeed fatal injuries may sometimes be produced. Without going so far as that, however, hooking the cricoid is always a troublesome accident.

I was called one evening to see a poor woman who had had a coin-catcher stuck in her throat for several hours; the stem of the instrument projected from between her teeth, and repeated efforts had failed to extract it. During the day she had bolted a large lump of meat, which had stuck in the gullet; her doctor had introduced the coin-catcher without any difficulty, but to his great stupefaction had been unable to withdraw it. The situation was becoming critical; the instrument seemed absolutely fixed, and all attempts to push it farther in or to incline it or give it a half twist had not the slightest effect. I decided to perform external œsophagotomy; the patient was anæsthetized, but before beginning the operation I thought I would make a last attempt; the stem was pushed strongly backwards and downwards towards the vertebral column as if I wished to push it through the posterior œsophageal wall; I felt something yield, and I was then able to withdraw the instrument, which still held some fragments of meat.

In another case of the same kind, M. Félizet introduced a large, well-oiled sponge mounted on a whalebone stem into the œsophagus; the sponge

in swelling dilated the canal above the basket of the coin-catcher, which he was then able to remove.

Some men are very clever in handling this instrument: it will be well to leave it to them; but in the general practitioner's equipment Kirmisson's œsophageal crotchet ought to be substituted for it. The crotchet is not so thick as the coin-catcher, and, having rounded margins, it slips easily behind the coin, which usually lies with its surfaces directed antero-posteriorly and applied to the anterior œsophageal wall (*Fig.* 189), and in returning the hooked end picks up the coin and readily brings it out.

The left index finger placed as low as possible (*Fig.* 192) serves as a guide for the introduction of the instrument, which is passed down along the posterior wall of the œsophagus until felt to strike against the foreign

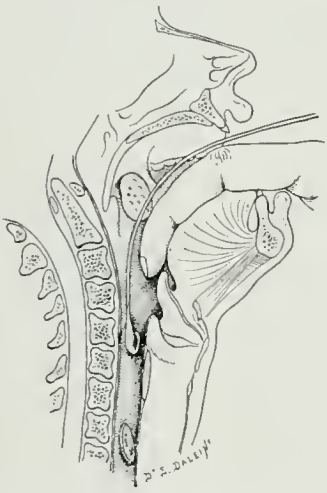


Fig. 192.—Using the œsophageal crotchet. The instrument is passed as far down as possible, along the index finger, which is depressing the base of the tongue.

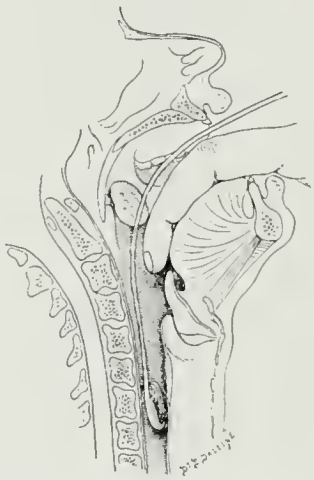


Fig. 193.—Using the œsophageal crotchet. The instrument has picked up the coin: extraction.

body, below and behind which the hooked end is made to pass by inclining the stem strongly forwards. As soon as the coin is felt to have been picked up (*Fig.* 193), pull directly upwards, keeping as exactly as possible in the middle line, with a steady continuous movement, and without jerking the instrument. When the last stage of the extraction, at the back of the mouth, has been reached, it is then necessary to accelerate the movement a little and finish by a sharp jerk which carries the coin outside the wide-open mouth before it can slip out of the grasp of the crotchet.

Some rounded or cylindrical bodies, such as fruit-stones or small dentures, lend themselves comparatively well to extraction with œsophageal forceps (*Fig.* 194 and 195). This instrument is introduced closed, and only opened when felt to be in contact with the foreign body: it must then be closed and withdrawn with great caution, and only after a definite sensation is realized of a solid body being caught between the jaws. It is seldom

that success attends the first attempt: in any case do not persist unduly with these efforts.

Needles, pins, and fishbones usually stick in the posterior wall of the canal; often, however, they are implanted into the back of the mouth or the pharynx, where they are more accessible. Fergusson's umbrella-probang—which is now rarely used—was specially designed for their extraction. It is introduced closed, and opened in the gullet below the point where the foreign body is supposed to be stuck, and in withdrawing it there is some chance of entangling the needle or other object in the radiating threads of which the distal end is composed.

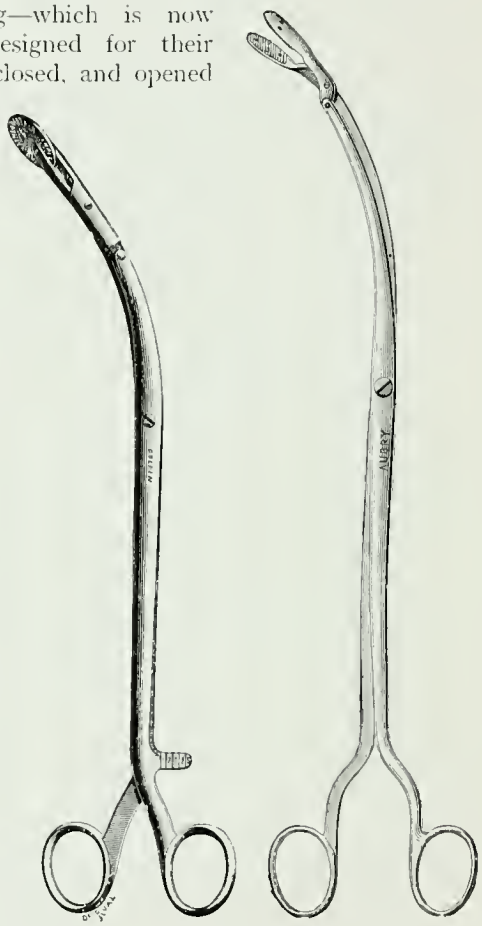


Fig. 194. *Fig.* 195.

Fig. 194.—Berger's œsophageal forceps, with scale to indicate the thickness of the foreign body.

Fig. 195.—Œsophageal forceps.

During the exploratory manœuvres, or in the attempts at extraction, the foreign body, particularly if rounded and with a smooth surface, is fairly often pushed on into the stomach. In such conditions, that is not a misfortune; indeed, *propulsion* is only to be feared when dealing with pointed, sharp-edged, or irregular objects which might wound the stomach or intestines. If, therefore, the exact nature and shape of the foreign body is not known, propulsion will be a blind and often a dangerous procedure; on the other hand, when dealing with fruit-stones, or bits of meat, or even with coins impacted very low down in the œsophagus, and where extraction by the mouth has been tried and failed, and is likely to be very difficult, it is much better simply to decide at once **to push the offending body on into the stomach.** For this purpose a good-sized œsophageal bougie will serve, fitted at the end with a bit of sponge if necessary. Here again the procedure must be carried out methodically: the instrument must be introduced gently and used without any degree of force, which might damage the wall of the canal. Lastly, the first sitting should not be a long one: there is

no urgency so long as there are no respiratory difficulties. The patient is fed with soups, white of egg, milk, etc., kept absolutely quiet, and perhaps given a little chloral or morphia; under this régime some foreign bodies will spontaneously disappear into the stomach.

It must be understood, however, that all these attempts at extraction —without visual aid—may be difficult and dangerous.

If recourse can be had to **œsophagoscopy**, it ought to be employed in the first instance; it is the surest and least dangerous method of exploration and extraction. Undoubtedly the method requires a special technique, special instruments, and previous experience; the difficulties are certainly real, but there is no need to exaggerate them, and it is highly desirable that the method should be practised much more often than it is, at least in surgical centres.[1]

We cannot here describe the various forms of œsophagoscopes; they are all based on the original model of von Mickulicz, who in 1881 was the first to use the straight œsophagoscopic tubes. One essential point of difference requires notice, the method of lighting: the instruments of von Mickulicz, von Hacker, etc., are furnished with a para-electroscope fitted to the outer extremity of the tube; in other forms the light is supplied by Kirstein's or Guisez's illuminator, which is carried on the operator's forehead, whence the light is directed down the tube.

Before using the œsophagoscope in the search for a foreign body, the back of the throat is anæsthetized with a 5 per cent solution of cocaine or a 3 per cent solution of β-eucaine, the back of the tongue, the roof of the mouth, the soft palate, the epiglottis, the aryteno-epiglottidean folds, the arytenoids, and the entrance to the œsophagus being swabbed over with a small piece of wool saturated with the solution employed, and carried in the jaws of a pair of curved forceps. Chloroform is only indicated in the case of children or very nervous subjects.

The patient lies on his back, with the shoulders extending a little way beyond the end of the table, the head being thrown well back and supported by an assistant, who raises or lowers it a little, according to the various stages of the operation.

If it is determined in advance, by the passage of the sound, at what level the object is arrested, a tube of just sufficient length will be chosen; if not, the longest must be used (45 cms.).

[1] The number of œsophagoscopic extractions now on record is the best proof of the value of the method. Up to 1901 von Hacker has had in his own practice twenty-three cases: in twelve of these the foreign body lay in a normal œsophagus, and a successful result was obtained in each; in eleven cases the foreign body was arrested at a stricture, cicatricial or malignant; in one case only was the attempt at extraction a failure. ("Ueber die Entfernung von Fremdkörpern aus der Speiseröhre mittelst der Œsophagoskopie." *Beitr. zur klin. Chir.*, 1901, xxix., 1, p. 128). In 1905 Hugo Stark collected seventy-eight cases: in fifty-two they related to a foreign body in a normal œsophagus: there were thirty-eight extractions, eight propulsions (by the tube), six failures (secondary gastrotomy or œsophagotomy being required); in twenty-six the foreign body was impacted in a strictured œsophagus: seventeen extractions, seven propulsions, two failures: the general mortality was 5 per cent. ("Die direkte Besichtigung der Speiseröhre, Œsophagoskopie. Würzbourg, 1905). In France Guisez has published a series of cases ("De l'extraction des corps étrangers par l'œsophagoscopie." *Gaz. des hôp.*, 6 mai, 1905, p. 615. "Modification et perfectionnements apportés à la technique et à l'instrumentation de la broncho-œsophagoscopie." *Presse médicale*, 4 sept., 1907).

The tube, fitted with its obturator, is carried behind the base of the tongue and gently introduced, keeping to the middle line, down to the level of the cricoid cartilage; then the obturator is withdrawn and the light directed down the tube, which is pushed on little by little, every portion of the œsophageal wall being illuminated and carefully examined as the tube passes down; the foreign body, fragment of bone, coin, etc., shows up clearly against the red background of the wall, at least in cases where it is not embedded in or enveloped by the mucosa; then it often shows only by some small point on its periphery, and an attempt must be made to expose it more freely.

If the cardia has been reached without finding anything, withdraw the tube slowly and repeat the examination from below upwards; it may happen that a small, pointed body stuck in the posterior wall, which has escaped observation during the introduction, springs up when the tube is being withdrawn over it, and allows itself to be detected by rubbing against the tube.

Before attempting to extract the foreign body it must be freed and got into the axis of the tube; these preliminary and often difficult manipulations are performed by means of special instruments. The actual extraction should be done through the tube if the object is small or can be broken up; in other cases it is seized with a suitable instrument and removed along with the tube.[1] In the case of very large and fixed bodies (large dental plates for example), and generally in any case where œsophagoscopic extraction has failed, external œsophagotomy must be performed, or gastrotomy if the seat of impaction is very low down.

Extraction by the external route is indicated as a primary procedure in the two following conditions: (1) In the case of a *very large, firmly impacted foreign body*, which completely obstructs the lumen of the œsophagus, prevents deglutition, and causes symptoms of laryngo-tracheal compression; (2) In the case of *a sharp-pointed or sharp-edged body*, the slightest movement of which might be dangerous—a knife-blade or a dental plate with many points, for example.

II.—THE FOREIGN BODY HAS BEEN IN THE PHARYNX OR ŒSOPHAGUS FOR SOME TIME.

In this category the foreign bodies are mostly found in the œsophagus, and a fresh factor has come to complicate the local situation, for the wall of the œsophagus is affected—thinned, and sometimes ulcerated, from contact with and pressure of the foreign body; it has become friable, and the *danger of perforation* is considerably increased. Moreover, the infection

[1] When there is œsophageal stenosis, two conditions may occur: if the foreign body is too large to pass, it is arrested above the stricture, and extraction is the same as in a normal gullet; or the foreign body may pass through the stricture and stick behind it, or even in some cases be imprisoned between two strictures: under such circumstances it is quite evident that the discovery of the obstacle and its extraction or propulsion into the stomach may be extremely difficult.

has often spread to the peri-œsophageal tissues, which are infiltrated and œdematous.

Even though no secondary lesions are evident, the practical conclusion to be drawn is that *all attempts at instrumental extraction* and *all explorations must be conducted with the greatest caution.*

Here again œsophagoscopy is indicated, either for exploration or extraction. If it fails in extraction, then it is necessary to operate.

If œsophagoscopy is not available, the resonating sound, very cautiously handled, may give useful information, at least with regard to the seat of

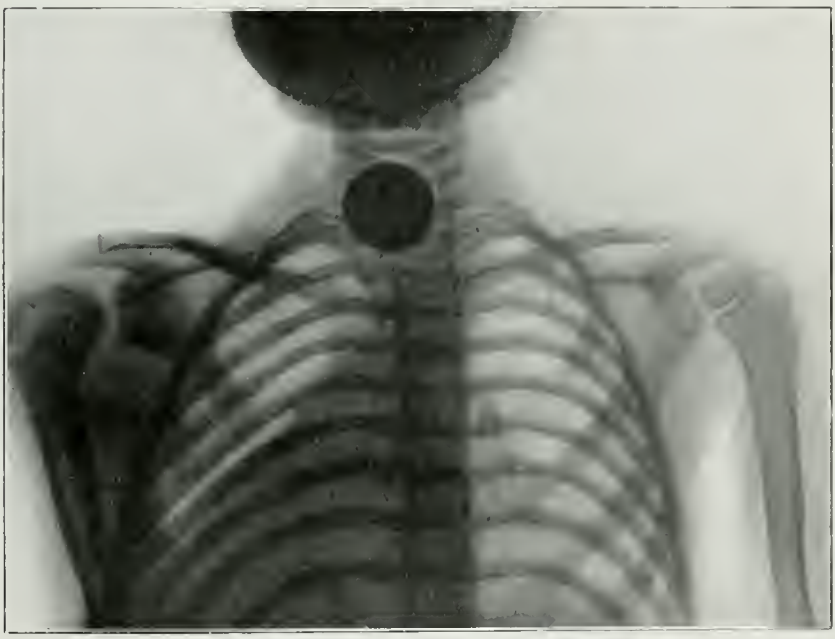


Fig. 196.—Radiograph of a coin impacted in the œsophagus. (JALAGUIER, *Soc. de chir.*, 1897).

the obstacle ; but its use is attended with difficulties which do not exist in recent cases. If the foreign body is small, it may be lodged between two folds of the mucous membrane, covered with mucus and particles of food, and thus give no definite indication on contact with the instrument. Quite often the sound may pass down to the stomach without finding anything very definite ; it is rare, however, that a slight jerk, or a local pain, or a little blood staining the end of the sound does not give some indication.

Radioscopy supplies the best guides when dealing with coins (*Fig.* 196), pins, pieces of bone, etc. It is, however, sometimes at fault, for several cases are on record where foreign bodies have been discovered by means of the œsophagoscope, which had not been shown by a radiograph, and *vice versa.*

If the foreign body is situated comparatively high up, and if fairly precise information has been obtained with regard to its site, form, and direction, an attempt may be made at extraction through the mouth by the methods already indicated, *but on no account must these attempts be persisted in* if they are not speedily successful: in such circumstances an external œsophagotomy is indicated.[1] The more marked the functional disturbances the more definite will the indication be; it will be absolute if there are already any signs of peri-œsophageal infiltration.

External Œsophagotomy cannot be considered a simple operation; although the prominence of the impacted object may sometimes serve as a guide and may considerably simplify matters, the search for and opening of the œsophagus—particularly in children—are always difficult. The operation to be satisfactory must be performed methodically and in certain definite stages.

The patient lies on his back with the shoulders raised by a hard cushion, the head moderately extended and turned to the right, in which position it is fixed by the two hands of an assistant, and the *left lateral region of the neck*[2] *is freely exposed.*

1. **Incision of the Musculo-aponeurotic Layers.**—Feel the cricoid cartilage, the carotid groove, and, deeply, the tubercle of the transverse process of the 6th cervical vertebra; remember that the tubercle (with the lower border of the cricoid cartilage) marks the beginning of the œsophagus, and that the inferior thyroid artery crosses a finger's breadth lower down. Presently the artery crossing the lateral border of the œsophagus will be met.

Make an incision beginning *a finger's breadth above the sterno-clavicular articulation and extending upwards to the level of the upper border of the thyroid cartilage* (*Fig.* 197); do not be afraid to make a long incision: plenty of room will be needed. The scalpel follows the visible and palpable anterior border of the sternomastoid, and the only objective for the moment is to lay the muscle bare and to retract it outwards.

Carry the incision right down to the red muscular fibres at once, dividing the skin, the pale fibres of the platysma, and the cervical apo-

[1] Foreign bodies in the pharynx are much more easily dislodged and extracted if the cavity is properly illuminated, and consequently pharyngotomy is much less frequently indicated than œsophagotomy. The pharynx may be opened in front (see Subhyoid Pharyngotomy) or laterally. M. Quénu has emphasized the simplicity and satisfactory results of this lateral pharyngotomy: by this route he has removed a dental plate impacted below the upper orifice of the œsophagus; the incision is made along the anterior border of the sternomastoid, and the great cornu of the hyoid bone, which constitutes the best guide to the further steps of the operation, is at once sought for; the thyro-linguo-facial venous trunk is divided between two ligatures, the external carotid is drawn outwards, and the lateral wall of the pharynx incised vertically just behind the tip of the great cornu. (*Bull. de la Soc. de chir.* 22 avril, 1903, p. 440).

[2] I need scarcely recall the fact that external œsophagotomy is always performed on the left side: (1) Because the œsophagus inclines to this side from behind the trachea, and is therefore more accessible; (2) Because the recurrent laryngeal nerve, lying in the groove between the trachea and œsophagus, is more easily avoided. A lesion of the recurrent nerve is one of the chief dangers of the operation: one must remember that the nerve lies in front of the œsophagus, which must therefore be attacked on its lateral aspect. The important point, however, is to allow abundant room, and to do nothing by guess-work in this region.

neurosis: apply two forceps to the divided ends of the external jugular vein, which will almost invariably be cut; expose the muscle throughout the whole length of the cutaneous incision, then by blunt dissection free its anterior border, draw it outwards, and place it under a retractor. The anterior compartment of the neck has now been opened up (*Fig.* 197). Examine it well. A red muscular band running obliquely from above downwards and from within outwards crosses the middle part of the wound: it is the *omohyoid muscle*, and below its upper belly will be seen its fibrous intersection, if the sternomastoid is well retracted.

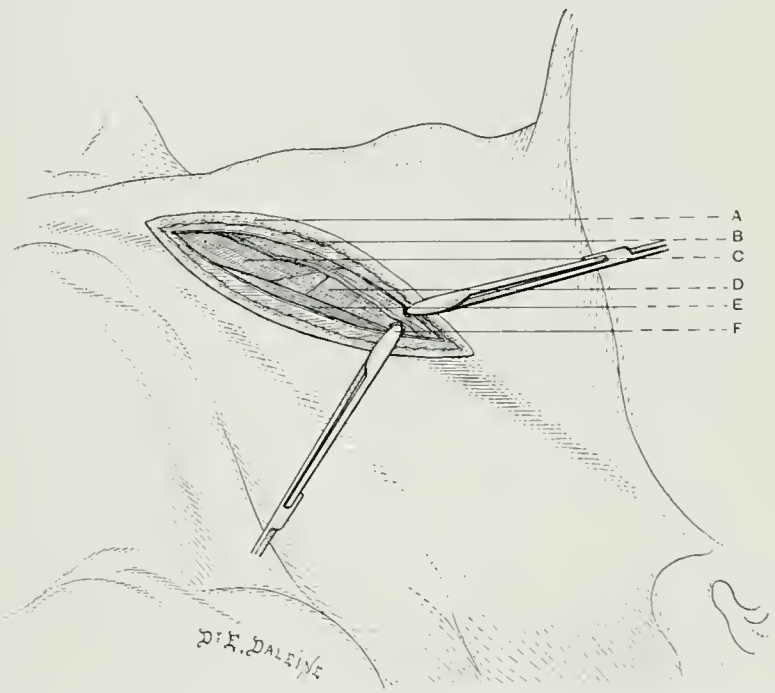


Fig. 197.—External œsophagotomy.—1st step.—(A) Subcutaneous fatty tissue. (B) Platysma. (C) Sternomastoid muscle. (D) Omohyoid muscle. (E) Anterior border of the sternomastoid. (F) External jugular vein, cut between two forceps.

Clear the upper border of the omohyoid with a stroke of the director, then slip the director under this border and down behind the muscle and the aponeurosis which stretches downwards from its lower border; divide the muscle and aponeurosis with a stroke of the knife. We have now penetrated into the deep part of the anterior compartment of the neck, and have lying under the finger *the great vessels externally* and *the trachea and thyroid body internally*.

2. **Displacement of the Lateral Lobe of the Thyroid Body, Exposure of the Trachea and Œsophagus.**—With the tip of the index

finger feel for the pulsations of the carotid artery and internally the resistant trachea. Expose the great artery by carrying the director up and down along its inner border, and after the vessel is freed, retract it outwards along with the jugular vein (which is not seen) and the overlying sterno-mastoid muscle. A broad retractor replaces the finger, and once the great vessels are safe, attention may be directed inwards and the trachea exposed.

With the director, clear and raise the outer border of the infrahyoid muscles; the trachea appears, more or less covered and masked by the left lobe of the thyroid body. The *inferior thyroid artery* (*Fig.* 198), accompanied by two veins and usually enveloped in a dense layer of connective tissue, runs towards the inferior angle of this lobe. Keep the artery in

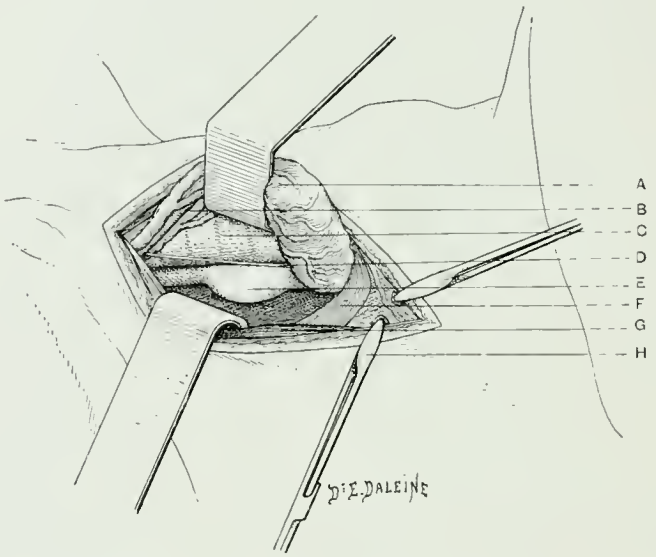


Fig. 198.—External œsophagotomy.—2nd step.—(A) Thyroid body, the left lobe of which is drawn forward. (B) Inferior thyroid vessels. (C) Trachea. (D) Recurrent laryngeal nerve. (E) Œsophagus: its wall is raised by the foreign body within. (F) Omohyoid. (G) Sternomastoid. (H) Forceps holding the external jugular vein.

mind and look for it at once, a finger's breadth above the tubercle of the transverse process of the 6th cervical vertebra, now definitely recognizable at the bottom of the wound. It will be found without much trouble; isolate it and retract it downwards and inwards. If it cannot be retracted easily, and gives any trouble whatever, divide it between two ligatures. Do not hesitate to do everything that is possible to expose the field of operation thoroughly; in the fat neck of a child or in the short, thick neck of some adults, it will never be possible to get sufficient exposure to make the operation easy. Now raise the left lobe of the thyroid body, taking care not to tear it,[1] cautiously disengage its posterior border, which more or

[1] If it is very large—"hypertrophied"—it might be advisable to excise it, after tying the two vascular pedicles, superior and inferior, at its extremities.

less overlaps the carotid artery, and retract it to the right along with the trachea under a broad retractor (*Figs.* 198, 199, 200).

The trachea constitutes the best guide for finding the œsophagus. The greyish and flattened appearance of the œsophagus always surprises and disconcerts an operator who is doing an external œsophagotomy for the first time; in any case, remember that *there is nothing but the œsophagus*[1] between the trachea and the vertebral column.

Frequently the prominence caused by the foreign body within the œsophagus will be seen, or may be definitely felt through the wall. In dealing with a comparatively recent case where the œsophageal wall is not

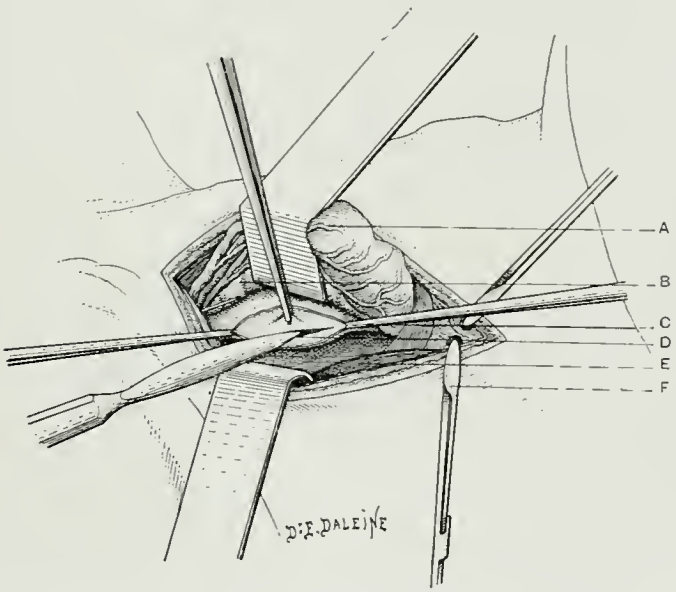


Fig. 199.—External œsophagotomy.—3rd step.—(A) Thyroid body. (B) Trachea. (C) Forceps lifting up the wall of the œsophagus. (D) Incision in the œsophagus. (E) Sternomastoid. (F) Forceps holding the external jugular vein.

much altered, before going on to open the œsophagus an attempt may be made to loosen the foreign body and to push it up with the fingers towards the pharynx, where it may be caught and extracted by forceps introduced through the mouth. This plan has been successful on several occasions;[2] naturally it is only applicable to foreign bodies lodged in the cervical portion of the gullet, and ought only to be tried with the greatest caution. If not successful after a reasonable attempt, do not persist, but proceed with the original operation and open the œsophagus.

[1] It is impossible to overrate the importance of this very simple point, which has been of the greatest service to us in two external œsophagotomies performed without internal guides of any sort.

[2] In the hands of MM. Kramer, Felix Funke, and Riedel.

3. **Opening the Œsophagus.**—Take hold of the wall of the canal along its left lateral border with two pairs of Kocher's forceps, draw it out a little, and incise it longitudinally immediately in front of this border (if possible over the projection of the foreign body). Do not forget that the wall is thick, and composed of an *outer muscular layer* and an *inner mucous layer*. The latter presents itself, after the muscular layer is divided, as a *whitish flaccid mobile membrane*, and must in its turn be gripped with forceps before being opened (*Fig.* 199).

We may say here regarding the œsophagus what we shall repeat when speaking of the stomach and intestines—so long as there is a doubt the operator may be sure that he has not reached the interior.

The incision must be proportionate to the size of the foreign body: nothing is gained by making it too small, and there is a risk of laceration, which may interfere with rapid healing.

Extraction by the wound may be easy or difficult. Elongated bodies must be tilted so that they present by one of the extremities. When the obstacle is situated low down and cannot be pushed onwards, it must be sought for with long curved forceps, and sometimes even a second way of approach must be made through the stomach (see below).

Should the Œsophagus be Sutured? There can be no doubt about the answer in certain conditions: if the wall of the œsophagus is seriously affected by prolonged contact with the foreign body, or owing to the attempts at extraction, or if the peri-œsophageal tissues are infiltrated and infected, then leave everything wide open, drain the operation area with a tube or a strip of gauze, and be content with approximating the extremities of the cutaneous incision.[1]

If the operation has been performed early, and the wall of the canal is healthy, or practically so, the opening in the œsophagus may be closed,[2] but the suture must be very carefully done to obviate the risk of leakage, and it will be advisable to leave a small drainage tube in the depths of the wound.

The mucous layer should first be united by means of a continuous suture of silk or catgut, and then the edges of the incision in the muscular coat adjusted by three or four interrupted sutures or by a second continuous suture (*Fig.* 200), picking up the whole thickness of the wall exclusive of the mucosa, and tied sufficiently tightly to obtain close approximation without cutting through. At the depth at which one is working, the

[1] It is useless in these cases to leave a tube in the œsophageal wound for the purpose of feeding the patient. Liquid nourishment should be administered from the beginning by the mouth: a certain quantity of the fluid naturally escapes by the wound, but as the wound is widely open no bad effects need be feared.

[2] In a collection of fifty-three cases of external œsophagotomy for foreign bodies, M. Kaloyeropulos found thirty-seven where suture had been practised, with a mortality of 8·3 per cent, and fourteen in which the œsophageal wound had been left open, with a mortality of 28·5 per cent (in two cases no details were given). The higher death-rate in the unsutured cases is explained, however, by the fact that they were initially the serious cases, because of the long presence of the foreign body, or because of lesions of the wall of the œsophagus. The general mortality of external œsophagotomy is about 15 per cent. (J. Kaloyeropulos, "Ueber Œsophagoskopie und Œsophagotomie bei Fremdkörpern in der Speiseröhre." *Beitr. zur klin. Chir.*, 1903, Bd. xxxviii., 2, p. 540).

application of this suture is often difficult ; a short full-curved needle in a needle-holder or held in the jaws of a pair of pressure-forceps is often more useful than a fine Reverdin needle. When the opening in the œsophagus is closed, the end of the drainage tube is placed in contact with the suture line, and the musculo-aponeurotic planes are closed by a continuous suture : the skin wound is sutured separately, an opening being left at the lower end for the passage of the drainage tube.

During the first few days after the operation the patient receives only liquid food, administered in very small quantities. In my opinion this method, which may be augmented if necessary by rectal feeding, is preferable to tube feeding, because the repeated introductions of the tube always cause dragging and stretching of the sutured œsophageal wound.

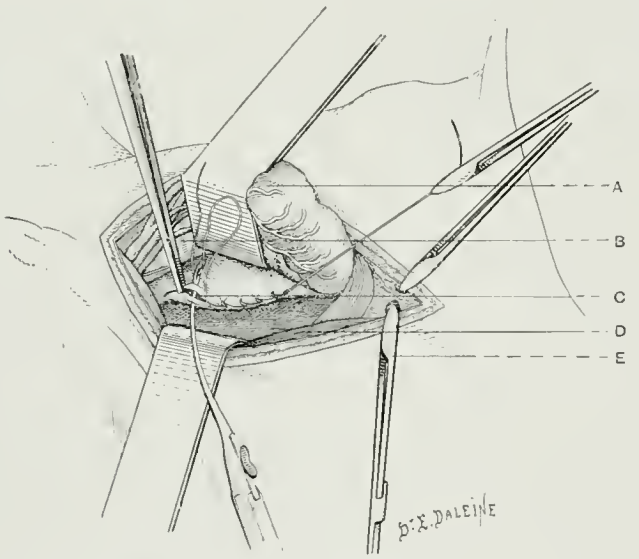


Fig. 200.—External œsophagotomy.—4th step. (A) Thyroid body. (B) Trachea. (C) Suture of the œsophagus. (D) Sternomastoid. (E) Forceps holding the external jugular vein.

The Foreign Body is lodged in the Lower Part of the Œsophagus.—Certain more complex procedures which only partly belong to the group of urgent operations are occasionally required in these cases : we refer to gastrotomy and the various associated manœuvres to which that operation serves as a preliminary.[1]

Richardson, of Boston,[2] was the first to perform this operation for the extraction of a foreign body from the lower part of the œsophagus : in

[1] In the literature up to 1002, fourteen operations of this kind are recorded. (See von Hacker, "Zur Frage der zweckmässigsten Verfahrens, um Fremdkörper aus dem unteren Theil der Speiseröhre vom Magen aus zu Entfernen." *Beitr. zur Klin. Chir.*, 1902, Bd. xxxii, 2, p. 532).

[2] Maurice H. Richardson, "A Case of Gastrotomy, Digital Exploration of the Œsophagus and Removal of a Plate of Teeth. Recovery." *Boston Med. and Surg. Journal.* 16 Dec., 1886.

his case a dental plate had been lodged in the œsophagus at a distance of 14 inches from the teeth for a period of eight months: he opened the stomach and, using a finger introduced into the cardia as a guide, passed a forceps into the gullet and succeeded in removing the foreign body.

The operation is far from being an easy one: the depth at which the cardiac orifice lies, and the difficulty of getting through it and of conducting the necessary manipulations above it, render that quite sufficiently evident. Therefore it is essential to open the stomach as near as possible to the cardiac end, high up and to the left.

Extraction may be carried out by means of the finger, or with the whole hand introduced into the stomach, or with instruments—curved forceps, bougies, etc.

If the stomach is brought outside the abdomen, it is quite impossible for the finger to reach the cardiac orifice, far less to pass through it and work in the œsophagus. Wilms[1] in one case met the difficulty in the following manner: he had to deal with a dental plate fixed in the œsophagus opposite the disc between the 8th and 9th dorsal vertebræ. A small zone on the anterior wall of the exposed stomach was circumscribed by a purse-string suture: at the centre of the zone a small incision was made, into which the index-finger was passed, and the suture was then tightly tied around the root of the finger. He then succeeded, by introducing the whole hand into the abdomen and invaginating the wall of the stomach, in getting the finger through the cardiac orifice and dislodging the plate: often enough, however, a single finger is not sufficient. The stomach is then kept outside the abdomen, and being carefully surrounded with gauze, a free incision is made in its anterior wall and the whole hand introduced into the cavity.

In other cases long curved forceps or œsophageal bougies, guided by a finger in the stomach, have been used; or again, the passage of bougies by the stomach and the mouth have been combined in various fashions.

William Bull, of New York,[2] performed gastrotomy to extract a peach-stone which was impacted at the lower end of the œsophagus in a girl of 16 years of age, but was unable to get hold of the stone; he therefore passed a fine bougie into the stomach by way of the mouth and fastened a sponge to its gastric end; on withdrawing the bougie, the sponge-tipped end brought up the stone.

Finney, of Baltimore,[3] in a somewhat similar case employed a converse method; a peach-stone was lodged 52 cms. from the teeth, and all attempts by the natural passages had failed to dislodge it; he performed gastrotomy and then passed a fine bougie from the stomach into the mouth, attached a sponge to the buccal extremity, and then withdrawing it from above downwards, brought the stone into the stomach.

[1] Wilms, "Die Entfernung von Fremdkörpern aus dem unteren Theil des Œsophages vom Magen aus," *Deut. Zeits. f. Chirurgie*, Bd. lx, p. 348.

[2] William Bull, "Gastrotomy for Digital Exploration of the Œsophagus and Removal of a Foreign Body," *New York Medical Journal*, Vol. xlvi., No. 18, p. 481, 29 Oct., 1887.

[3] Finney, "A case of Gastrotomy for Peach-stone in the Œsophagus," *Bulletins of the Johns Hopkins Hospital*, 1892, Vol. 888, No. 16.

In one case I also employed gastrotomy, and the introduction of an œsophageal bougie from below upwards, for the purpose of removing a pile of copper coins which a radiograph had shown to be stuck in the lower segment of the canal. The abdomen was opened in the middle line above the umbilicus, and the stomach drawn out and incised on its anterior surface, midway between the two curvatures and parallel to its long axis, for a length of 10 cms. A bougie introduced by the cardiac orifice, from below upwards into the œsophagus, gave me at once the sensation of a foreign body lying behind it. The bougie was pushed on beyond the foreign body, and I then withdrew it from above downwards, at the same time inclining its outer end as far as possible forward in the hope of dislodging the obstacle and causing it to fall into the stomach. The manœuvre succeeded, and I withdrew a mass of coins, five of 10 centimes, one of 5 centimes, all stuck together. The opening in the stomach was closed by a double continuous suture, and recovery followed without any complication.[1]

Whether a finger or a sound is used, before passing it into the cardia, the lesser curvature of the stomach should be put on the stretch. This very important detail facilitates the introduction considerably by obliterating the mucous folds and by directing the finger or instrument towards the opening.

It must be understood that extraction of œsophageal foreign bodies by the gastric route is only justifiable in exceptional circumstances, and must be restricted to cases where it is impossible or dangerous to remove the obstacle by the aid of the œsophagoscope or by propulsion.

ABSCESSES OF THE NECK.

The task of opening a deep abscess in the neck is not always an easy one; even a submaxillary abscess may cause some difficulty: further, in certain cases the operation may be required under very urgent conditions to avert impending asphyxia or septicæmia.

When called to a patient with an enormous swelling occupying the whole of the submaxillary region, and extending over the lower part of the face, the practitioner should not wait until fluctuation can be detected: this may not be apparent for a considerable time. The acute pain, the tenderness to pressure, the doughy swelling, the subcutaneous œdema, and the diffuse redness of the skin, are sufficient proofs of the presence of pus;

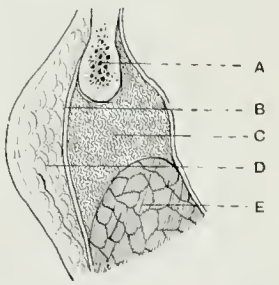


Fig. 201.—Submaxillary abscess (vertical section). (A) Maxilla. (B) Aponeurosis. (C) Abscess. (D) Œdematous subcutaneous tissue. (E) Submaxillary gland.

[1] The patient some days before the operation had passed by the bowel three 5-centime pieces, and later, three more coins, one of 10 centimes and two of 5 centimes. Altogether she had swallowed twelve coins. ("Gastrotomie pour corps étrangers de l'œsophage," *Acad. de méd.*, 10 jan., 1899).

but though present without doubt, it is still imprisoned below the cervical aponeurosis.

It will be seen by *Fig.* 201 that in order to open the **submaxillary abscess** two steps are necessary: (1) *To incise the skin with the scalpel;* (2) *To rupture the aponeurosis with a director.* Never stop half way, and do not be surprised to find nothing under the skin.

Make a horizontal incision about an inch long, a finger breadth below the lower border of the jaw, keeping in front of the region where the facial artery might be injured (*see Fig.* 104). Then take a strong director and attack the tense resistant deep layer at the middle of the incision; push the end of the director through the aponeurosis, enlarge the opening in the aponeurosis by side-to-side movements of the instrument, at the same

Fig. 202.—Opening a submaxillary abscess with the director.

time directing it *upwards and forwards towards the mouth* (*Fig.* 202). Conducted in this manner, the manœuvre is without danger, and very soon the pus will be seen to escape.

We need merely refer to the **sub-angulo-maxillary** abscesses which occasionally develop in connection with a wisdom tooth, and which occupy the extreme posterior part of the submaxillary region; they are opened through a slightly curved incision around the angle of the jaw (*Fig.* 203), and the end of the director works *upwards and forwards towards the angle.*

The situation is much more serious in the presence of **submaxillary cellulitis.**

A young man, twenty-six years of age, the day after the extraction of a tooth was taken ill with shivers, and dull pain in the submaxillary region, and quickly fell into a strange condition of depression. A moderate

degree of diffuse swelling appeared in the suprahyoid region. I saw him two days later; the temperature was 103°, the pulse rapid and feeble, the tongue dry, and the eyes sunken; the whole suprahyoid region was occupied by a uniform œdematous swelling, almost painless, with areas of purple discoloration; the swelling surrounded the upper part of the side of the neck; it raised the floor of the mouth a little, and presented the same characters of diffuse infiltration over its whole extent. The region was freely incised with the thermo-cautery; from each opening some sero-sanious brownish fluid escaped, but no pus. After a transitory improvement the symptoms of infection returned in an aggravated form, and the patient died, comatose, forty-eight hours after operation.

Fig. 203.—Incision for opening a sub-angulo-maxillary abscess.

Another example: A young woman was brought to the Beaujon Hospital in a state of complete cyanosis, and apparently dying; the face was purple, the eyes were protruding, respiration was extremely difficult and quite superficial, and the pulse imperceptible. The neck was surrounded by a thick reddish swelling, soft, œdematous, without fluctuation, which extended from one side to the other over the whole of the suprahyoid region. The illness dated from some days previously. Immediate tracheotomy was evidently necessary, but before anything could be done the patient died, asphyxiated.

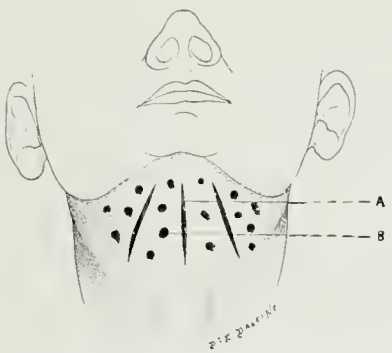


Fig. 204.—Multiple openings made with the thermo-cautery in a case of submaxillary cellulitis (diagrammatic). (A) Longitudinal incisions. (B) Deep punctures.

I could cite other examples: by whatever name they are called—submaxillary cellulitis, diffuse suprahyoid phlegmon, or Ludwig's angina—these terrible cases are not uncommon: they cause death either by *acute toxæmia* or by *asphyxia*. In dealing with them we are almost helpless: or at least a stage in the illness very quickly comes when any treatment is useless. If surgical measures are to be adopted with any hope of success the diagnosis must be made at the beginning of the trouble.

This diffuse submaxillary cellulitis must be treated in the same way as diffuse cellulitis of a limb. *Open up the sub-aponeurotic tissues freely with*

the thermo-cautery by cutting deep antero-posterior grooves in front and at the sides into the midst of the infected and infiltrated tissues and, in the spaces between the incisions and also at the margins of the infiltrated area, make numerous deep punctures with the thermo-cautery point at a red heat (*Fig.* 204), being careful to avoid the track of the great vessels: it is a barbarous method, but is the only treatment of any real value. Lastly, pack the wounds with gauze soaked in hydrogen peroxide solution, and cover up the whole area with a large dressing moistened with the same solution.[1]

Lower down in the neck, in the sternomastoid and subhyoid regions, one will sometimes meet with deep-seated suppurations, often difficult to localize precisely, which may produce urgent symptoms of suffocation and consequently need immediate incision.

Here again, the surgeon will often have to do with a puffy swelling or even with a diffuse infiltration, rather than a definite and fluctuating accumulation. In opening them up, the technique already indicated should be followed, the knife incising the skin and superficial tissues, and the director working in the depths; or in place of the director, the thermo-cautery knife may be used at a dull-red heat.

A thyrohyoid abscess is sometimes met with, occupying the superior laryngeal region and spreading above the hyoid bone and towards the floor of the mouth. *A median vertical incision* should be employed in these cases, and may be extended if necessary into the median raphe above the hyoid bone.

We may also mention the *perilaryngeal* and *peritracheal abscesses*, always more prominent on one side than the other, and which are most conveniently reached by a lateral incision parallel to and a little in front of the anterior border of the sternomastoid muscle, and certain grave and asphyxiating forms of *suppurative thyroiditis*. A young woman, twenty-two years of age, and seven months pregnant, was brought to us in a very alarming condition: temperature 104°, pulse 130, difficult respiration, symptoms of acute infection and of suffocation. The front of the neck was occupied by a large oval fluctuating swelling, apparently situated in the right lobe of the thyroid body; the overlying skin was reddened. An incision gave issue to a large quantity of dark, fœtid fluid, and opened up a large intrathyroid cavity, which bled freely. A little pressure soon stopped the bleeding. The symptoms abated, and the patient recovered and was confined normally two months later.

In opening these intrathyroid abscesses, it is advisable in urgent practice to use the thermo-cautery, as, if the wall is incised with the knife, serious bleeding may occur.

Dealing with lateral abscesses, and leaving aside the superficial suppurations, we shall refer first to the **abscess in the sheath of the sternomastoid**; the **substernomastoid abscess**; and **Dupuytren's large abscess.**

[1] Hydrogen peroxide 12 volumes per cent. Frequently spray the wound area also with the same solution, and employ it in half strength for swabbing out the mouth and nose. Large infusions of saline solution should be administered.

An abscess in the sheath of the sternomastoid may occupy any point in the length of the muscle, to the form of which it more or less definitely corresponds; it descends sometimes as far as its lower attachments, and there becomes superficial. This is the point for incision in such a case: at other times, when the abscess extends only to the upper part of the muscle, it will be opened at the most prominent point.[1] Other collections of pus, usually of glandular origin, are found below the sternomastoid: fluctuation only becomes perceptible very late, and operation must be undertaken without waiting for it; an incision must be made in the way we shall presently describe, exposing the anterior border of the sternomastoid, in order to retract it and search for the abscess; a second incision along the posterior border of the muscle is sometimes useful by allowing through-and-through drainage.

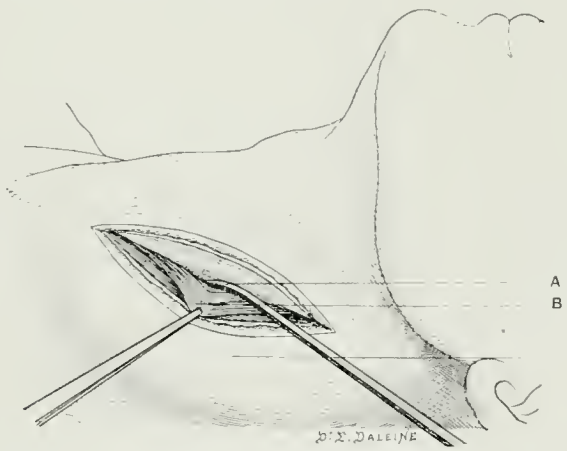


Fig. 205.—Opening a substernomastoid abscess. (A) Director working along the deep surface of the muscle from within outwards. (B) Anterior border of the muscle retracted by forceps.

Dupuytren's large abscess is rare, and is characterized by the appearance of a large flat swelling, hard and red, extending over the whole side of the neck from the jaw to the clavicle, and from the middle line behind to the trachea in front; despite its alarming appearance, this abscess does not usually exercise any deep pressure, but softens and breaks down at several points. It is always well to treat it early by multiple incisions.

But the most serious form of lateral abscess, and that which most frequently causes urgent symptoms, is the **diffuse deep abscess of the neck** (Tillaux).

A man fifty years of age was taken ill after a chill, with fever, shivers, and a painful and steadily increasing stiffness of the neck which was soon complicated by the development of a diffuse swelling of the whole

[1] Remember that these abscesses often originate from a diseased mastoid process, and that their incision ought then to be combined with mastoidectomy.

of the left sternomastoid region. When brought to hospital four days later, the corresponding side of the neck was raised *en masse* over its entire height, and at some depth, under the tense and prominent muscle, a thick indefinitely fluctuating layer could be felt. Respiration was whistling, difficult, accompanied by indrawing of the chest, and the dyspnœa was rapidly becoming worse.

What is to be done under such circumstances? Tracheotomy, or opening up the deep-seated focus of suppuration?

Excluding cases where death from suffocation is imminent, and it is imperative to give the patient air at once, the correct procedure is to open up the seat of suppuration and evacuate the abscess, thus relieving the trachea from pressure; this will meet all indications.

Make a long incision *on the anterior border of the sternomastoid* with its centre at the level of the maximum prominence of the swelling. Now expose the red muscular border; this is the first and most valuable guide. After raising and retracting its border, continue the search below, and in contact with, the muscle by means of the director (*Fig.* 205).

The proximity of the great vessels—carotid artery and jugular vein—constitutes a great and very real danger, especially when one considers that the vessel walls may be softened and infiltrated from contact with the pus. All blind and forcible manipulations must be absolutely proscribed. In the depths of the wound the finger must always precede the director, feeling for the carotid pulsations and guiding itself by the tense swelling which indicates the position of the focus of suppuration. The director will be handled very cautiously, working up and down parallel to the deep surface of the muscle, which it strips up little by little.

Of course, when the chief prominence of the abscess appears posteriorly, raising the posterior border of the muscle, the route so indicated will be followed, with the various precautions already mentioned.

Lastly, when dealing with a *diffuse swelling* which infiltrates the whole region and extends to both sides of the neck, it will be well to follow Chassaignac's practice and make the incision in the middle line down to the trachea, and through the opening to continue the search on either side, from within outwards, with the finger and director.

The large median incision, combined if necessary with others on the posterior border of the sternomastoid, over the lateral surface of the muscle, and also very cautiously made along its anterior border, is the most suitable method of dealing with those cases of infective œdema of the neck included under the title of cervical cellulitis.

SECTION II.—THE THORAX.

SUBCUTANEOUS INJURIES OF THE THORAX.

This group includes *Contusions of the thorax*, *Fractures of the ribs and sternum*, and their complications.

Contusions.—These injuries are often limited to the wall, but when they are *deep* and result from the application of considerable force, they may be complicated by serious lesions of the thoracic viscera, such as rupture of the lung or the heart. Immediate or very rapid death is then a common result; in case of less injuries, certain urgent operations are sometimes indicated. (See Ruptures of the Lung, Puncture of the Pericardium, and Pericardiotomy).

Again, after violent blows on the chest, even when there is no evidence of fracture, the possibility of *traumatic* (*contusion*) *pneumonia* must always be kept in mind. Blood-spitting, immediately after the injury, or delayed until the next day, should always attract attention; a rise of temperature, often comparatively small, indicates the onset of the pulmonary complication, which is generally a very serious one.[1] Therefore, in practice, it is advisable in any case of contusion of the thorax to give a guarded prognosis, and to keep the patient at rest and under close observation for some time.[2]

Diffuse ecchymosis of the face and neck, resulting from compression of the trunk (Stauungsblutungen) must also be mentioned. It is a rare condition, but has very definite characteristics. The patient has been buried under a fall of earth, doubled up under the wheels of a vehicle, etc.; when liberated his face and neck are seen to be swollen and quite blue. The discoloration—more or less deep, and sometimes almost black, and mottled with reddish spots—covers the whole face and descends on to the neck, where it terminates in a very definite circular border about the level of the shirt collar: the eyelids are swollen, the eyes protrude, and the conjunctivæ are ecchymosed. At first sight the appearance is very strange and alarming; however, it is not usually associated with very grave lesions, and at the

[1] Traumatic pneumonia ends fatally in one case out of three; it is usually associated with the early development of an asthenic state; it may lead to a pulmonary abscess or give rise to a suppurative interlobar pleurisy. (Claisse, "Les contusions du poumon." *Gazette des hôpitaux*, 30 mai, 1905, p. 735.)

[2] At the end of eight days, if there is no fever, no dyspnœa, no doubtful expectoration, one would be justified in setting aside the fear of pneumonia. These points indicate how much caution is necessary in expressing an opinion with regard to an injury incurred during the course of employment.

end of about twelve days the condition has completely disappeared. It is indeed a symptom of traumatic asphyxia.

Fractures of the Ribs.—Never omit to auscultate these cases; in addition to bony crepitation, which can sometimes only be detected by the ear, by the use of the stethoscope information can be obtained with regard to the single element of danger associated with fractured ribs, the pleuro-pulmonary complications (pneumothorax, traumatic pleuro-pneumonia).

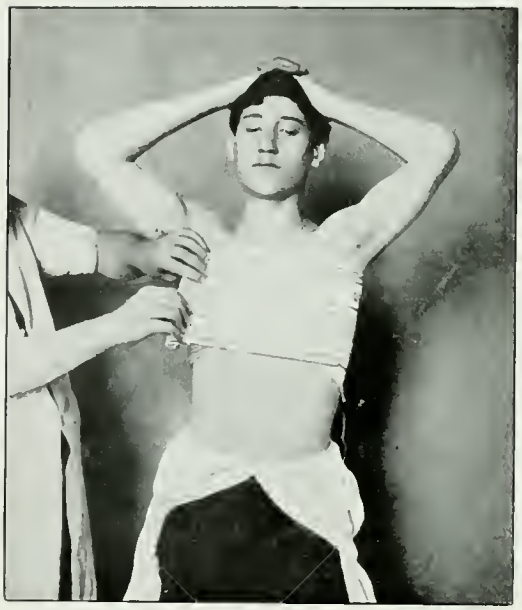


Fig. 206.—Application of a diachylon bandage in a case of fractured ribs.

The traditional diachylon bandage is the best means of treatment if properly applied — in other words, if it is broad, reaching the axillæ with its upper border, and is put on firmly and uniformly. (*Fig.* 206).

Multiple fractures and crushes of the thorax are often complicated with pulmonary lacerations or spreading emphysema. Surgical intervention will be required under the conditions which we shall presently mention (see later). When a large segment of the costal wall is detached in front and behind, and depressed into the thoracic cavity, it may become necessary to raise it, and visceral complications being the rule in such cases, the operation must be carried out through a large flap incision, in order to give ample room for dealing with the underlying conditions.

Fractures of the Sternum.—These are uncommon (though perhaps less so than is often thought), usually transverse, and seated at the junctions of the different constituent parts of the sternum, and particularly at the junction of the manubrium and the body.[1]

They must always be thought of and looked for, not only after contusions of the front of the chest, but also after falls and violent muscular efforts, (parturition for instance), as the sternum may be broken by muscular action, from the opposed traction of the sternomastoids and the abdominal recti.

[1] A dislocation may occur when the two upper segments have not united.

If the lower fragment projects very prominently forward, it ought to be reduced. The patient is placed on his back, with the head fully extended, and a cushion laid longitudinally between the scapulæ, and while the shoulders are pressed strongly backwards by an assistant, the operator pushes against the projecting fragment with both thumbs. Once reduction is obtained, it can be maintained without trouble by keeping the patient on the interscapular cushion, which raises the chest and causes it to bulge out in front.

It will be well to be somewhat guarded with the prognosis, even in cases of very simple fractures, and not to forget the possibility of retrosternal hæmatomata; these may be large enough to fill the anterior mediastinum and cause serious compression symptoms, and though they are usually absorbed, they have sometimes given origin to a suppurative mediastinitis.

It is only in one or other of the following three rare conditions that urgent operation may be required: (1) *In ruptures of the lung*, with or without fracture of ribs, followed by a very large hæmothorax; (2) In certain cases of *generalized emphysema* consecutive to fracture of ribs; (3) In the *subcutaneous herniæ of the lungs*.

1. **Rupture of the lung** may occur in association with fractures of the ribs, and particularly in the case of multiple fractures with depression; it is not only from the lacerated lung that blood is poured into the pleura, but also from the parietal vessels, the intercostals, the internal mammary vessels, and sometimes even from secondary branches of very small calibre.

But a tear of the lung may also occur from a violent contusion of the thorax without any lesion of the parietal skeleton. A boy eleven years of age fell from a carriage, and one of the wheels passed over his chest; he picked himself up, but soon fell down again unconscious; he lost some blood from the nose and mouth; these initial symptoms soon passed, but the temperature began to rise, and on the fourth day he was taken to Professor Garré's clinic at Königsberg;[1] his condition was then very serious, the pulse being feeble, and oscillating between 132 and 140; the face was cyanosed, and respiration was laboured; the apex of the heart was displaced to the right, and the signs of a very extensive hæmopneumothorax were detected at the left base. Seven ounces of blood-stained fluid were removed by aspiration with only very transitory relief. Respiration became very rapid and superficial, and the pulse was intermittent; operation was therefore immediately undertaken.

Through a lateral oblique incision two inches of the left 6th rib were resected and the pleura was opened. The lung was found to have retracted towards the spine; a laceration about three inches long was seen in the upper lobe, beginning about an inch behind the tip of the precordial angle and passing upwards and backwards; the edges of the tear were everted and separated by a space of half an inch to an inch. After enlarging the

[1] Georg Richter, "Ueber Lungenrupturen." *Beitr. zur klin. Chir.*, 1904, xliv., 1, p. 140.

parietal opening, the lobe was drawn into the wound and the laceration closed by five interrupted silk sutures, introduced at about half an inch from the margins of the fissure and penetrating deeply into the lung tissue; adjustment of the edges was made as accurately as possible, and two superficial points of suture were introduced to complete it.

After cleansing the pleural cavity, the upper lobe was sutured to the lower, and fixed to the thoracic wall. Unfortunately, the patient died on the second day; at the autopsy the edges of the pulmonary wound were found to be already adherent; there was no fracture of the ribs.

M. Georg Richter has collected twenty-three cases of these ruptures of lung without fracture of ribs, or at least wholly independent of the parietal lesion if a fracture existed. Whether the pulmonary laceration is or is not associated with a fracture, if it is extensive the symptoms are the same: there is a large and increasing hæmopneumothorax, steadily advancing subcutaneous emphysema, a serious degree of anæmia, with signs of cardiac and pulmonary compression, to which those of pleural infection are more or less quickly added.

The prognosis is always very serious; in thirty-seven cases of pulmonary rupture with or without fractures, M. Richter found twenty-three deaths, a mortality of 62 per cent.

Apart from conditions of extreme and immediate urgency, it is best to keep the patient absolutely still, and wait until the initial shock has passed off; to combat dyspnœa by the sitting position and inhalations of oxygen, etc., and the anæmia by repeated subcutaneous injections of saline solution in small doses. The early symptoms may improve, and at the end of two or three days a puncture, by emptying a large part of the pleural accumulation—without going so far as to risk disturbing hæmostasis—may be followed by considerable improvement, and finally a cure may be obtained by these simple means.[1]

But in the grave cases when the hæmopneumothorax is causing progressive and dangerous dyspnœa, and when the heart is becoming increasingly feeble, more active measures will give the patient the best chance of recovery. The chest should be opened, and the pulmonary laceration sought for and sutured. The operation should be performed at the site of fracture if there is one; if not, the chest should be opened at its middle latero-posterior part, in the way we shall subsequently describe. (See p. 227.)

2. **In a case of spreading emphysema,** following a fracture of one or more ribs, which extends to the base of the neck and causes cyanosis and serious suffocative symptoms, it is advisable to make a free incision into the inflated area, so providing a way of escape for the air. We have found this method very useful on two occasions.

With regard to those exceptional cases of generalized emphysema, we cannot do better than summarize an interesting report by Bramann[2]

[1] Bouilly, "Des épanchements sanguins de la plèvre," *Gazette méd. de Paris*, 1884, p. 24.

[2] Bramann, "Ueber die Bekämpfung des nach Lungenverletzungen auftreteden allgemeinen Körperemphysems." *Deut. Gesells. f. Chir.*, 1893, xii. Kongress.

and describe the ingenious procedure employed by him with striking success.

Case 11.—The patient was a workman aged 29 years: a vehicle weighing 50 cwt. had passed obliquely over the right side of the chest. Half an hour later emphysema had extended to the neck, thorax, abdomen, thighs, and arms. The third and fourth ribs on the right side were fractured in the axillary line, and at that point a most definite bubbling sound could be heard during inspiration. Six hours later the emphysema had reached the feet and hands, and spread over the whole of the face and head; the patient's entire body, indeed, bore some resemblance to a gaseous tumour. The feeling of oppression was extreme, the pulse was scarcely perceptible, and the face was cyanosed.

Immediate intervention was evidently necessary. It was supposed that there was a pulmonary fissure opposite the position of the fractured ribs. An incision was therefore made over the fourth rib, two inches of which were resected; a trocar passed into the pleural cavity allowed a great quantity of air to escape; the pleura was then opened, but the pulmonary fissure could not be found; it appeared to be near the hilum of the lung, and was inaccessible.

The operation was therefore terminated in the following manner: a large thick-walled drainage tube was placed in the pleural cavity, and the wound in the soft parts was closely sutured around it; consequently the air which was forced into the pleural cavity at each inspiration through the pulmonary laceration, was able to escape by the tube during expiration, and no longer tended to infiltrate the soft tissues of the body. To the end of the drainage tube, which projected about an inch beyond the surface of the chest, a second piece of tubing of thin soft rubber was fitted; the flaccid walls of the second tube allowed the expired air to escape, but during inspiration fell together, and so prevented any entry of air by that route.

The result was excellent: the emphysema diminished rapidly. By the sixth day the pulmonary wound had apparently closed; on the eleventh day the tube was removed and the thoracic wound completely sutured. By the sixteenth day there was no sign of pneumothorax, and after a serious attack of bronchitis, which lasted from the fourth to the sixth week, complete recovery ensued.

3. **Traumatic Pulmonary Hernia, without a Wound.**—We need merely mention this condition; it is very uncommon, but MM. Reynier and Poirier[1] have recorded some curious examples. M. Reynier's patient was a man of sixty-one years of age who had been struck by the end of a carriage shaft. The crepitating tumour was exposed by incision, a small tear in the protruded lung was sutured, and the protrusion reduced; the breach in the thoracic wall, the hernial orifice, was then closed. An uneventful recovery took place.

WOUNDS OF THE THORAX.

Under this heading we shall include wounds caused by sharp instruments (knife, sword, sabre, unguarded foil, dagger, etc.), and wounds caused by firearms (usually revolver, pistol, or shot-gun in civil practice).

[1] *Société de chirurgie*, 30 oct., 1895.

Wounds of the lower thoracic zone often implicate the diaphragm and penetrate the abdomen: these will be considered separately.

Practically it is useless to lay any stress on injuries which extensively affect the heart or the great vessels; immediate or very rapid death is the almost invariable result, and as a rule there is not time to think of surgical intervention.[1]

We shall discuss the subject under the following sub-divisions: (I) *Penetrating wounds of the pleura and the lung;* (II) *Thoraco-abdominal wounds, wounds and ruptures of the diaphragm;* (III) *Wounds of the pericardium and the heart.*

I.—PENETRATING WOUNDS OF THE PLEURA AND THE LUNG.

A wound of the chest causes death by **hæmorrhage**, by **asphyxia**, or by **infection**, and to these may be added **syncope**, especially in wounds of the left side. These general points govern the indications and treatment.

The difficulties in the way of a free approach to the interior of the chest, the special anatomical and physiological characters of the lungs, and the usual inability to determine precisely the seat of the visceral lesion, prevent the full application to these cases of the general treatment of penetrating wounds of the body cavities; commonly we are compelled to limit ourselves to meeting the more pressing indications while leaving the rest to nature; there is always an element of doubt in the prognosis of these injuries. Excluding certain urgent conditions of which we shall speak presently, in dealing with any wound of the chest, irrespective of the character of the agent producing it, the general practice ought to be: **make no exploration, disinfect the parietal wound and close it immediately, keep the patient absolutely quiet and under strict observation, and wait.**

These principles are particularly applicable in wounds resulting from duels.[2] One of the combatants has received a sword thrust in the chest. Have him transported very gently and without any jolting to the *nearest possible place* where treatment can be instituted; cut away the garments; soap and wash the whole wound area; bathe the wound itself with alcohol and boiled salt solution; separate the lips of the wound; if any parietal vessel is bleeding, pick it up with pressure-forceps and apply a ligature; if there is any oozing of blood from the depths of the wound, do not

[1] This statement is not, however, absolutely true, for after such injuries the patient has been known to live for days or even months. Perthes collected eleven cases in which, after bullet wounds of the aorta, the patient lived for times varying from six to sixty days, and his own case is still more curious: the bullet had entered at the second intercostal space, had opened the left pulmonary artery on its posterior aspect, completely perforated the descending aorta, and finally lodged in the transverse process of the sixth dorsal vertebra. A communication was established between the pulmonary artery and the aorta. The patient lived for ten months. (G. Perthes, "Schussverletzung der Arteria Pulmonalis und Aorta, mitgetheilt auf Grund zehnmonatlicher klinischer Beobachtung und des Sektionsbefundes." *Beitr. zur klin. Chir.* 1897, Bd. xix., II, p. 414). These are of course very exceptional cases: bullet wounds of the heart, on the other hand, have several times been followed by long-continued survival, and even by complete recovery. (See Wounds of the Heart).

[2] Huguet et Péraire, "De la conduite du chirurgien dans les cas de plaie pénétrante de poitrine par arme blanche." *Revue de chir.*, 1895, No. 1, p. 26.

be unnecessarily alarmed, nor for the moment attempt to do anything more ; suture the wound, cover it with a layer of aseptic gauze, fixed at the margins with collodion ; over this apply a thick layer of wool, and secure the dressing with a bandage applied firmly and evenly around the chest. Put the patient to bed, lying on his back with head and shoulders raised with pillows, and keep him motionless and in silence in a half-darkened room. Nothing is likely to be worse for the patient than to take him a considerable distance in any chance vehicle, in the midst of noise and excitement ; the nearest covered place to the duelling-ground is always the best ; numerous well-known instances have fully demonstrated the dangers of hasty flights.

Naturally, the same precautions should be observed, as far as possible, after any other stab wounds. The general rule remains the same : *close the wound and keep the patient at rest.* The practitioner, while recognizing the vital importance of these initial measures, must of course adapt his treatment to the exigencies of the case.

After bullet wounds, such as attempts at suicide with a revolver, which are so common in large cities, first aid should follow the same lines.

A young man about twenty years of age had just fired a revolver bullet of 7 mm. calibre into the left side of his chest. We found him stretched upon his bed, pale, with sunken eyes, greatly agitated ; the pulse was good, there was nervous respiratory distress rather than actual dyspnœa. The outer garments were removed and the shirt slit up ; at the level of the 5th left intercostal space a small blackened wound was found, from which a little blood was oozing ; it was at once washed and brushed with soap and water, then bathed with ether and sterile saline solution, and closed with a disc of gauze fixed by collodion. Without allowing the wounded man to sit up, he was rolled round on to the opposite side, and with the eye and hand a careful search was made over the posterior aspect of the chest for a wound of exit or for the bullet embedded in the soft tissues ; nothing was found, however. Percussion and auscultation (with the patient always in the horizontal position) revealed nothing but a comparatively limited effusion. The patient was then turned on to the injured side so as to permit a rapid examination of the other half of the chest ; a broad binder with a thick layer of wool was slipped under him and carefully and firmly applied. Absolute rest in bed, with the administration of a little opium, completed the primary treatment. No matter how apparently simple the injury may be, it is never advisable to depart from these elementary rules.

At the time when one of these cases is first seen it is impossible to determine the nature and extent of the deep lesions. The character of the projectile, the general appearance of the patient, and even the results of a direct examination, cannot give definite information with regard to the prognosis.

Therefore, even when dyspnœa is great and the pulse feeble, and even if a considerable effusion is detected, there is no immediate cause for alarm, and still less for active interference. The sitting position in bed, subcutaneous injections of saline solution, the administration of caffeine and camphorated

oil, inhalations of oxygen, etc., will enable the initial period of shock to be tided over. Make no exploration of the wound, either with finger or probe. Cleanse it carefully with warm boiled water, soap, and alcohol, and apply a dry aseptic dressing, a thick layer of wool and a broad binder—nothing more. It is scarcely necessary to add that in such a case the patient must be closely watched; but, at least so far as revolver bullet-wounds are concerned, experience has shown that the progress of the case is often favourable,[1] sometimes even in spite of severe primary symptoms.

These methods are applicable to injuries of average gravity; in other cases urgent indications present themselves, perhaps immediately after the accident, but more often at a somewhat later period.

1. Primary Operations.

These are required most frequently for *hæmorrhage*, external or intrapleural, and the resulting symptoms of *acute anæmia or asphyxia*—sometimes for *pulmonary hernia*.

(*A*). **External Hæmorrhage.**—When this has been considerable—from an extensive wound caused by a sword thrust or a knife stab, less frequently by gunshot or bullet—the blood runs in a large continuous stream, except during expiration, when it is expelled in jets. The patient's clothing is soaked, occlusion of the wound is impossible, and an external dressing is speedily saturated. If there is no hæmoptysis, we may presume the blood comes from the vessels of the thoracic wall; there can be no certainty with regard to that point, however; in any case, it is necessary to act at once.

Lose no time trying any of the many empirical hæmostatic devices recommended in the older text-books. To open up the wound freely is the only way to deal quickly and successfully with the situation.

Packing after Desault's method may be useful, but only as a temporary measure to allow of an unavoidable transportation of the patient. A square of aseptic gauze is cut, the centre of the sheet is grasped with forceps and thrust through the wound into the thoracic cavity; strips of gauze are then packed tightly into the intrapleural sac thus formed. By pulling on the enveloping layer of gauze, the plug is pressed firmly against the inner surface of the chest wall; gauze is then packed into the extra-thoracic portion of the envelope, the corners of which are tied tightly over the contents; in this manner the wounded area is compressed both from *within* and *without*. This is **Desault's plug**, and is simply a modification of the

[1] This appears to be the case also with regard to wounds caused by military bullets of small calibre: in forty-two cases of bullet wounds of the lung, collected by M. Hildebrandt during the South African campaign, there were only five deaths (12 per cent); in two cases only did the hæmothorax suppurate. (Hildebrandt, "Beobachtungen über die Wirkungen des klein-kalibrigen Geschosses aus dem Boeren-Kriege, 1899–1900," *Arch. f. klin. Chir.*, Bd. lxv., p. 760.) During the same war, and still more notably during the Russo-Japanese war, the harmful results of long and premature transportation were observed, fatal secondary hæmorrhages occurring on several occasions.

Mickulicz tampon. (*See Fig.* 11). Properly and aseptically applied, it may sometimes be useful in parietal hæmorrhages, but usually it is inadequate; the blood speedily soaks through, and other methods become necessary.

Open the wound up freely; do not hesitate to make an incision several inches long in the skin, and sponge it free of blood. No definite bleeding point may be visible, the blood flowing from the depths of the wound, below the ribs. Introduce a finger into the opening, and press it against the inner surface and lower border of the adjacent rib; if the bleeding ceases, it will be known that its source is the intercostal artery which lies under the operator's finger, and an attempt can be made to seize the vessel with pressure-forceps. If this presents the slightest difficulty, resect part of the rib above or below; incise the periosteum along the rib, strip it up with the elevator, and two cuts with the bone forceps will allow of excision of the necessary costal segment and reveal what ought to be done.

The **internal mammary artery** is as a rule comparatively easily exposed and ligated. If it is certain from the seat of the wound that this vessel is the source of the hæmorrhage, and there are difficulties in the way of tying it at the point of injury, it will be a simple matter, and safer, to expose it above and below. It descends vertically, *between the costal cartilages and the pleura, a finger's breadth from the border of the sternum;* it is easily exposed, after section of the skin and muscular layer, by a horizontal incision beginning at the sternal border and passing outwards over the interchondral space. The operation is quite as easy as on the dead subject, the only precaution required being the careful isolation of the vessel with the director from the parietal pleura, to which it is closely applied: the position of the vessel is marked by a streak of fatty tissue. It is very important, when ligating in continuity, to apply ligatures both *above* and *below* the seat of injury; similarly, if successful in finding the bleeding vessel in the wound, *both ends* must be ligated, because the anastomoses of the artery and its terminal branches with the intercostal, phrenic, and epigastric vessels are so free that ligation above and below the seat of injury is always necessary.

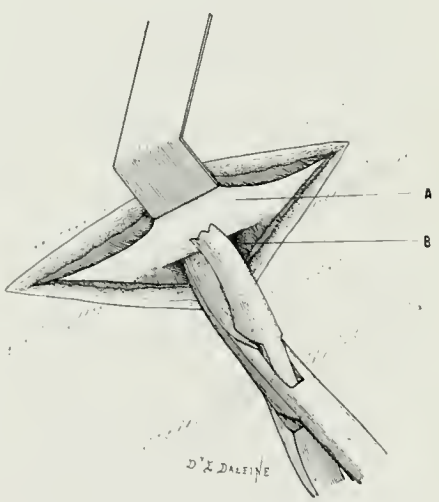


Fig. 207.—Checking bleeding from an intercostal vessel by crushing the lower border of the rib. (A) Rib. (B) Intercostal tissues.

It is often difficult to get hold of the intercostal arteries, embedded as they are in the subcostal grooves. Usually, however, one can manage to seize the vessel with Kocher's forceps applied close to the lower border

of the rib; the forceps may be left in position, but this is never, in my opinion, anything better than a makeshift; on the other hand, attempts to apply a ligature over the forceps often fail: the forceps tears off, and the vessel which had been seized with such difficulty is lost.

The following plan is very much better: Incise the periosteum close to the border of the rib, and separate it from the deep surface of the bone with the elevator; the vessels are thus freed from the bone, along with the periosteal flap, and it is then easy to pass a curved needle around them, behind the point where the forceps are applied. The bleeding may also be checked by *crushing the lower border of the rib* with a pair of lion forceps (*Fig.* 207). We have often employed this very simple measure with satisfaction during the course of extensive costal resections, when the thoracic wall was thickened and indurated.

(*B*). **Intrapleural Hæmorrhage.**—In other cases the bleeding from the wound is not very profuse, because of the small size or irregularity of the wound, or its elevated position; but the patient presents all the signs of *rapid effusion into the pleural cavity;* he is pale and anxious, his extremities are cold, the pulse is feeble and fast, the respiration difficult. Sometimes there is no hæmoptysis, but often the patient is spitting up blood, and during the respiratory movements blood and air bubble noisily through the wound.

Although the initial symptoms may be very serious, they by no means always demand immediate operative intervention; operation under these circumstances is hazardous and difficult, requiring special instruments, skilled assistance, and a very real mastery of surgical technique. Here again, free enlargement, if necessary,[1] and careful cleansing of the external wound, followed by suture and occlusion under a compressive dressing, absolute immobility, injections of caffeine and camphorated oil, represent the whole of the immediate treatment—treatment which is within the powers of any practitioner, and to which interference may be limited if, in the hours immediately following, the initial symptoms are relieved, the pulse strengthens, the dyspnœa becomes less, and the thoracic dullness does not extend.

In some circumstances, however, such treatment is quite inadequate. It is useless in the two following conditions: (1) **When the injury is followed immediately by the filling of the pleura with blood,** when the dullness extends very quickly up to the apex of the cavity, while at the same time the feeble pulse, intense pallor, and anxious face indicate a degree of anæmia presaging rapid death; (2) **In the presence of a rapid and simultaneous aggravation of the general symptoms and the physical signs,** the hæmothorax enlarging and extending higher, while the dyspnœa becomes great and the pulse very poor.

In neither case can any indirect procedure prevent a fatal issue. Pleural puncture, while it may in some degree relieve the pulmonary

[1] When, owing to the narrowness and valvular character of the cutaneous wound, the subcutaneous emphysema is increasing and extending widely.

compression, can only aggravate the anæmia. In fact the question simply is, *Shall we let the patient die, or operate?* Under such circumstances *immediate operation is necessary*.

The cases in which operation has been undertaken for pulmonary wounds are now comparatively numerous.[1] No very definite rules can well be formulated to regulate the operative technique, but a study of various reported cases allows certain general principles to be recognized.

It is to be noted first of all that a certain number of these operations have not been, in the strict sense of the word, primary procedures, but have been undertaken on the second, third, or even on the ninth day, as for instance in the first cases of Delorme,[2] of Quénu, and of Michaux.[3]

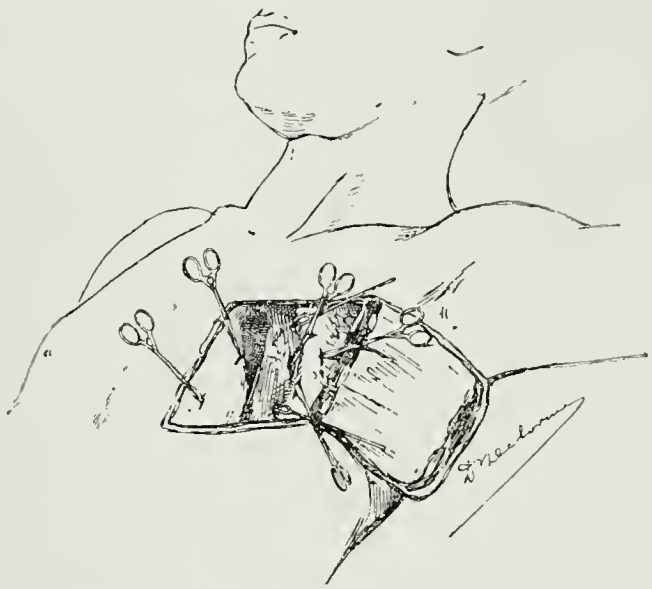


Fig. 208.—Drawing from nature representing Delorme's operation. Two forceps are placed on the pericardium, three on the lung. (*Congrès de chir.*, 1893, p. 427).

[1] M. Thierry de Martel, in his thesis (*Le traitement opératoire des hémorrhagies immédiates consécutives aux plaies du poumon*. Paris, 1907), has collected forty-two cases, with twenty-eight recoveries and fourteen deaths (33 per cent).

[2] An officer had received four stab wounds with a double-edged amputating knife in the region of the heart. He was brought, bloodless, to Val-de-Grâce, where the external wounds were at once closed. On the second and third day fresh hæmorrhages occurred, and on the evening of the third day another bleeding, still more profuse. Death appeared imminent in default of operation. A free incision was made into the intercostal space, where the largest of the wounds was situated, and through the opening a wound in the lung, from which blood and air escaped during expiration, was seen, but could not be reached. A large thoracic flap, consisting of the soft parts and the ribs, with the base postero-superior, was cut and raised. Three pulmonary wounds were then found and closed with pressure-forceps: one of them being further closed by the application of a silk ligature grasping the whole of the lung tissue around the opening. Two pairs of forceps were applied to wounds in the pericardium (*Fig.* 208); a strip of iodoform gauze was placed between the lung and pericardium, then the flap was replaced and sutured in position. The patient died a quarter of an hour later. The autopsy showed that no pulmonary wound had been overlooked. (Delorme, "Contribution à la chirurgie de la poitrine" *Comptes rendus du Congrès de chirurgie*, 1893, p. 422).

[3] In several of them, intrapleural hæmorrhage and its results were not the only factors which rendered operation necessary, but infection also was an agent in causing urgent symptoms.

In recent years, immediate operations, within the first few hours of the first day, have become more frequent; we shall summarize, as examples, two cases of Ombredanne and Cottard, in which operation was performed three-quarters of an hour after the receipt of injury.

A young soldier[1] had fired a revolver shot (8 mm. calibre) into his precordial region; the wound of entry was situated 1 in. outside the left nipple: there was no wound of exit. The wounded man was extremely pale and collapsed, the whole left side of the chest was dull, and respiratory sounds were inaudible there. The pulse was small and rapidly becoming more feeble. Operation was at once undertaken. A flap, measuring 5 in. vertically, 4 in. horizontally, with the wound of entry at its centre, was rapidly cut: the 4th, 5th, and 6th cartilages were divided, the 3rd and 6th intercostal spaces were opened transversely; it was then possible to raise the whole flap to a right angle with the thoracic wall without fracturing the ribs posteriorly (the patient was only 21 years of age). "A stream of black blood and some enormous clots escaped from the wound; then the pink-coloured lung was protruded through the opening. I grasped it, and directly under my hand in the centre of the anterior surface I found a lacerated wound, the size of a two-shilling piece, from which a large jet of blood was flowing. I compressed the lung tissue around the opening between my fingers, forming a sort of cone, to the base of which I applied transversely a pair of Kocher's forceps, which I replaced at once with a ligature of No. 2 catgut. I cleared the pleura of the clots which filled it, wiped out the cavity with gauze, and then discovered that red blood was still escaping in abundance from the bottom.

"I therefore brought the lung altogether outside the chest, and turning it forwards on the hilum, on its posterior surface I found the wound of exit, much smaller than the anterior wound, but bleeding profusely. I dealt with this wound in the same manner as with the first, by the application of forceps, replaced by a mass ligature, to a cone of pulmonary tissue. I again dried out the wound, and this time hæmostasis was complete. The pericardium was uninjured. The parietal flap was replaced and sutured, a drainage tube being left in the 6th intercostal space. On the fifteenth day a considerable pleural effusion had to be evacuated by a posterior incision in the 8th space; the cavity closed gradually, and in two and a half months the patient had completely recovered."

"A man of 36 years[2] was brought to the Saint Louis Hospital, having fired two revolver bullets into the left side of his chest. The external hæmorrhage was insignificant; the two wounds were situated over the 4th and 5th left spaces, 5 in. and 4 in. distant respectively from the middle line; laterally and posteriorly, the dullness extended half way up the chest, the heart sounds were somewhat muffled, and the apex beat could not be felt.

[1] Ombredanne, "Double plaie du poumon traversé de part en part par une balle de revolver. Hémothorax grave. Thoracotomie. Sutures. Guérison." *Société de chirurgie*, 19 fév., 1907. Also M. Delorme's report, *Ibid.*, 5 juin, 1907. p. 598.

[2] Cottard, "Double plaie de poumon guérie par la suture." M. Beurnier's report, *Bulletin de la Soc. de chir.*, mars, 1907.

"It being thought that the heart was wounded, immediate operation was undertaken. A flap with its base anteriorly, extending from the 2nd to the 6th space, was cut, and, after division of the 3rd, 4th, and 5th ribs, turned inwards. A large quantity of dark blood escaped, and the pericardium was then found to be intact. The lung, which slipped from under the fingers, was seized about the middle with forceps and the lower lobe brought outside the chest. This lobe was found to be perforated through and through; an opening about $\frac{1}{4}$ in. in diameter was found on the anterior surface, and another posteriorly; each was closed with a suture of No. 1 catgut, passed with a curved Reverdin needle, through the mass of surrounding lung tissue. Blood still continued to well up from the depths of the cavity. The whole lung was therefore dislocated forward, rotating about its pedicle, and a third wound was then found on the outer surface of the upper lobe, while quite near to it a hard body was felt, embedded in the superficial part of the lung; the visceral pleura was torn open at this point, and the bullet found and extracted. The two wounds were closed in the same manner as those in the lower lobe. The pleural cavity was dried out, and the flap sutured in position. Five inches from the spine an inch of the 9th rib was excised, and through this dependent track a short, wide drainage tube was passed into the pleural cavity.

"After some trouble from pleural infection, the patient was cured in fifty-five days."

Cases of this kind, in which direct hæmostasis of a pulmonary wound has been practised, are no longer exceptional. If we add to those collected by M. Thierry de Martel[1] the more recent observations of Depage, Schütte and Küttner,[2] we obtain a total of 28 cases[3] with 8 deaths (approximately 28·5 per cent). Without laying undue stress on the figures, it is quite evident that thoracotomy for hæmorrhage is, in certain conditions, a life-saving operation.

General Technique of the Operation.—The essential point is to provide very free access. Performed through a narrow opening the operation is nothing but a sham, and would be much better not attempted at all.

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[1] Not including Garré's case of pulmonary rupture (see p. 217).

[2] Depage, *Bull. de l'Acad. de méd. de Belgique*, 25 jan., 1908. Schütte, *Münchener medic. Woch.*, 30 June, 1908, No. 26. Küttner, "Zur Behandlung schwerer Schüssverletzungen der Lunge mit primärer Naht." *Deutsche Zeitschrift f. Chir.*, 1908, xciv. 1, 2, p. 1. Depage's operation was undertaken eighteen hours after the accident with the aid of Mayer and Danis's apparatus (endo-pulmonary hyperpressure). The case was one of bullet wound in the precordial region. The flap, comprising portions of three ribs, was turned outwards: the blood and clots were evacuated, and a wound about half an inch in diameter was found in the midlde lobe, and closed with two silk sutures. By lowering the endo-pulmonary pressure the lung was allowed to retract a little in order to facilitate the cleansing of the pleural cavity, but was again distended before the external sutures were introduced. No drainage. Healing took place without the least complication.

Küttner operated in Sauerbruch's pneumatic chamber, forty-eight hours after a bullet wound of the precordial region. He first exposed the sixth rib and resected four inches of it, but access being insufficient, he removed two and a half inches from the 5th and 7th ribs. He then saw some bubbles of air which had a strong ethereal odour (the patient was anæsthetized with ether) escaping from the lower lobe; on this lobe he found a wound at the junction of the anterior border and the external surface, and another posteriorly: both were closed with silk sutures. A longitudinal laceration of the diaphragm was also sutured. The wound was closed without drainage. Healing in twenty-four days.

[3] Amongst these were 22 cases of pulmonary suture, with 2 deaths; 6 of pulmonary ligature, with 5 deaths. Of the 22 sutures, 5 were performed for stab wounds, and all of these patients recovered; 13 for bullet wounds (2 deaths).

If the external wound is of some size and is bleeding, make your first incision through it and prolong it in a line parallel to the direction of the ribs. Two secondary incisions made at the extremities of and at right angles to the first will enable you to raise the soft parts in two flaps and to expose as many ribs as are necessary. The incision being H-shaped.

Usually, however, it is advantageous to cut one *large flap*, to strip it up quickly, and under it to excise portions of several ribs, or, better still, to fashion an *osteoplastic flap*, including all the tissues of the thoracic wall (ribs and soft parts).

1. **Large Flap with Multiple Costal Resections.**—Make a large U-shaped incision, with the base postero-superior (*Fig.* 209) and with the two parallel limbs sufficiently far apart to include at least three ribs; go straight down to the chest wall, dividing with one continuous cut the skin, subcutaneous tissue, and the perithoracic muscles; then dissect up this musculocutaneous flap, which strips up easily under traction, and have it held out of the way by an assistant with a large retractor. The ribs and intervening intercostal muscles are now before you. Incise the periosteum along the whole length of the exposed portion of the lowest rib, and strip it up quickly with the elevator, especially on the deep surface of the rib, so as to liberate the intercostal artery and expose the lower border of the bone; with some deftness this can be done very quickly; a cut with the bone forceps at the inner end, another at the outer end, and the costal segment is removed. Repeat the same manœuvre, with elevator and bone forceps, on the second rib, the third, etc.

Fig. 209.—(L) U-shaped thoracic flap, with postero-superior base.

Only the soft parts of the wall now remain: make an incision through the intercostals and pleura along the upper border of the rib which bounds the area inferiorly, introduce the finger into the pleural cavity, and, using it as a guide, divide the wall along its anterior margin with scissors, applying forceps to the two ends of each intercostal artery as it is cut; do the same with the upper border and then turn back the **musculo-pleural flap.**

2. **Osteoplastic Flap.**—A very large flap should be cut, including four or five ribs: the 3rd, 4th, 5th, and 6th, and if necessary also the 2nd: *the transverse flap with posterior base*, recommended by M. Delorme, gives the best exposure. By an incision representing three sides of a rectangle, the flap is marked out. The general direction of the flap is somewhat oblique from above downwards following the line of the ribs, its anterior border is two finger breadths from the sternum, and the base corresponds to the axillary border of the scapula (*Fig.* 210). After the edges of this flap have been dissected up, the ribs and intervening intercostal tissues

along its anterior border are divided. As the intercostal arteries are cut, forceps are applied to each of the cut ends. Behind, the ribs are cut or resected to a limited extent, or—and more simply—fractured, by pressing strongly against the outer surface of the thoracic wall at the point where the break is to be effected, while forcibly raising the flap; the tissues in the intercostal spaces at the margins of the flap are divided along the upper borders of the corresponding ribs. The flap may then be turned back, exposing freely the interior of the thoracic cavity.

Temporary resection can also be performed by means of a flap with an anterior base (see *Figs.* 216 & 217) or by a vertical flap which is raised in one piece with the overlying tissues from below upwards. The two incisions which bound the vertical flap on the inner and outer sides are made at right

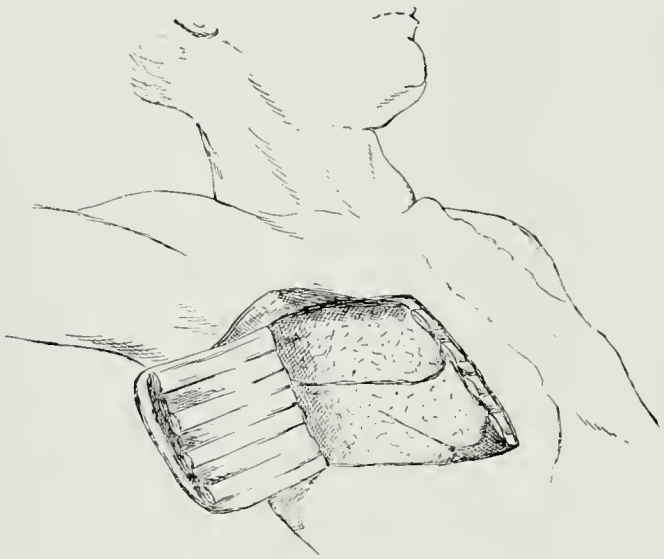


Fig. 210.—Osteoplastic thoracic flap turned back (Prof. Delorme's method). (*Congrès de chir.*, 1893, p. 423).

angles to the ribs, and the lower incision parallel to the upper border of the 6th, 7th, or 8th rib: the two lateral incisions go down to the bone, and by the retraction of the margins the ribs are sufficiently exposed for the subsequent division. The intercostal tissues and the pleura are divided below in a line with the inferior limb of the incision; then, working from below upwards, the ribs and intercostal tissues are divided, in front and behind alternately, care being exercised to seize both ends of each intercostal artery as it is cut. The whole mass can then be turned back on to the upper part of the chest.

The operator who recognizes the necessity for abundant room in carrying out the intrathoracic manipulations, and the facility with which intercostal hæmorrhage, so troublesome in a narrow wound, can be dealt with under such conditions, will never fail to provide very free access.

Once the chest is opened, the effused blood and clots are quickly evacuated, and attention is directed to the lung. The best plan is to seize it about the middle with forceps and draw it forwards. Wounds of the outer surface are the most easily accessible; if nothing is seen on the exposed area, then the lower lobe will be raised and the anterior margin drawn outwards, so that the inner surface and the hilum may be examined; sponge continually, and seek to follow the blood-track back to its source. In bullet wounds, when one of the openings is found, the other must always be sought for, and in doing that it must not be omitted to explore the posterior pulmonary border.

Pulmonary hæmostasis is by no means an easy matter, in the conditions under which it has to be undertaken, and because of the friability and vascularity of the pulmonary tissue.[1]

Suture with medium-sized materials (No. 2 catgut or silk) passed deeply through the lung tissue from side to side of the wound is the method of choice. In the case of a small wound the adjoining lung tissue may be seized by forceps and raised up in the form of a small cone, around the base of which a mass ligature may be tied.

Packing is merely a make-shift; sometimes, however, it is the only practicable method. Properly done with aseptic gauze, the ends of the strips being carefully placed in the pulmonary wound, it may suffice to check the bleeding, the gravity of which in this region, as in the abdomen, depends to a considerable extent on the fact that the blood flows into a large cavity, with moving walls, which act like a suction pump. If satisfactory hæmostasis has been obtained by suture or ligature,[2] the pleural cavity is carefully dried out, the parietal flap replaced, and the wound closed without drainage.[3]

(*C*). **Hernia of the Lung.**—Apart altogether from profuse hæmorrhage, immediate operation may be necessitated by this comparatively rare condition.

If the injury is a recent one, a tumour presenting all the appearances of lung tissue will be seen at the bottom of the wound, which is usually fairly large and often due to a sword-cut or stab from a knife. The tumour may be of variable dimensions, as large as the fist or an egg, pink or reddish in colour, smooth and crepitant. Soon it becomes purple or blackish, and crepitates less, passing in fact into a condition of "splenisation." Later still it becomes black, flaccid, and gangrenous.

The indications vary according to the date of the injury and the condition of the pulmonary protrusion. If the hernia is recent and

[1] In dealing with a bullet wound of the apex of the lung, Omboni, of Cremona, made a 5-inch incision through the 3rd intercostal space, drew the apex into the wound and resected it, after having ligatured the base with catgut; the patient died of pyæmia. (*Annali Univ. di med. et chir.*, t. cclxxi., p. 32).

[2] Never forget to examine the pericardium. In three cases where the bullet had perforated the heart and the lung, both wounds were sutured and two of the patients recovered. (P. Delbet Goebell. Wilms.)

[3] At all events if dealing with a recent injury: if drainage is considered to be necessary it is better to make a special posterior opening in a dependent position by excising an inch of the 8th or 9th rib.

the lung tissue is uninjured, it ought to be reduced. Before doing anything else the wound must be carefully disinfected; then a fold of aseptic gauze is spread over the protruded pulmonary segment, and the operator begins by freeing the mass at its circumference, at the same time exercising continuous pressure over the central portion, and thus gradually expelling the contained air. If operation is undertaken at an early stage, reduction is not usually difficult; should any trouble be experienced, however, it can be quickly overcome by excising part of one of the constricting ribs: the protecting fold of gauze will prevent any sudden inrush of air into the pleural cavity at the moment when reduction takes place, and will also act as a plug in the opening while the suturing is being done. In this way sudden collapse of the lung, which used to be considered a contraindication to any attempts at primary reduction, can be avoided.

A wound found in the protruded lung must be closed by a hæmostatic suture before the hernia is reduced. If the wound is large and the lesions are extensive, it will be necessary to excise the mass after ligating its base.

Indeed, **when the hernia is of several hours' standing,** or dates from the previous day, or if the lung tissue is lacerated, soiled, or of doubtful appearance, one should no more think of reducing it than of reducing a suspected loop of bowel: *it must be resected.* This is done by passing a double thread of catgut or silk with a blunt needle through the base of the herniated mass, which is then tied in the same manner as a pedicle and the portion beyond the ligature cut away with the thermo-cautery. After careful disinfection, the stump is liberated and restored to the pleural cavity, which it will then always be wise to drain.

If the pulmonary hernia is already old, shrivelled up, and dead, the best practice is to limit interference to cleansing the mass carefully and leaving it to separate spontaneously. A considerable number of recorded cases show that the outcome of this process of natural elimination is usually favourable.

2. Secondary Operations.

The situation may be complicated some days after the remission of the initial symptoms, or even at a comparatively remote date, by the sudden development of serious conditions demanding immediate intervention.

Notwithstanding a large primary effusion, the initial shock has passed off and respiration has become regular and fairly deep: in fact the case is apparently one of hæmopneumothorax of moderate extent pursuing a favourable course. But on the fourth, fifth, or sixth day, sometimes later still, there is a return of urgent symptoms—pallor, feeble pulse, threatening asphyxia; the thoracic dullness increases and extends up to the level of the spine of the scapula; the bulging and immobility of the chest and the complete absence of breath sounds on the affected side indicate a considerable enlargement of the effusion. This rapid increase of the intrapleural contents may be due to an inflammatory effusion resulting from the traumatic pleurisy, or, as we have already mentioned, it may be due to secondary hæmorrhage.

If there be no fever, or at least, *no signs of serious infection*, the best practice—at the stage we are considering—is first of all **to aspirate the chest.**

If the fluid withdrawn is dark coloured, slightly or not at all coagulable, there is a good chance that the evacuation of the pleural contents in this manner will be sufficient; at any rate it will relieve pressure and meet the more urgent indications.

This was the case in one, amongst others, of our patients at La Pitié. Ten days previously he had fired a revolver bullet into the left side of his chest. The effusion had been moderate in quantity and had not caused

Fig. 211.—Gunshot wound of the thorax. (Radiograph taken six months after the accident.) In the upper part of the lung a collection of fragments of lead are seen; they are embedded in the pulmonary tissue.

much trouble; then there was a sudden increase of the effusion, the pleura was filled, the heart displaced, and the general symptoms became very serious. I punctured the chest and drew off about three pints of dark, blood-stained, uncoagulable fluid. The symptoms were at once relieved, and the patient recovered without any further trouble. Several very definite cases of this kind were published quite a long time ago by Bouilly.

On the other hand, if the puncture shows bright *red blood*, you must look out for a rapid return of the hæmorrhage, and hold yourself in readiness to open the chest on the first reappearance of urgent symptoms.

There is also a second possibility: the increase of the effusion and the aggravation of the functional difficulties are associated with a rise of temperature (101°, 102°, or higher); the pulse is very fast and rather small, the skin is hot, there are sweats, sometimes shivers, in fact undoubted evidences of *pleural infection*. There is no longer a choice of operations: aspiration is useless: therefore open the pleura freely, empty it and provide good drainage. The following case will serve as an example:—

Case 12.—A boy, fifteen years of age, had fired a pistol bullet into the right side of his chest. He lost a good deal of blood from the small wound; but the primary symptoms soon subsided, and the case seemed to be one of simple and moderate hæmothorax running a favourable course. On the tenth day, however, the situation altered; the temperature went up, respiration became difficult, and the intrapleural contents increased to such an extent as to open up the small wound in the chest wall, from which a considerable quantity of blood-stained fluid escaped. I operated in the following manner: an incision about three inches long was made over the intercostal space where the wound of entry was situated, and the subjacent rib resected subperiosteally; I then penetrated into an enormous cavity extending to the lowest limit of the thorax and filled with breaking-down blood-clot and blood. A second incision was made over the 8th space and the 7th rib resected for about two and a half inches. Through the large opening thus made the pleural cavity was cleared of its abnormal contents and then washed out with boiled water. Two large drainage tubes were passed through the cavity from one opening to the other, and the wounds partially sutured. The operation was followed by a very satisfactory recovery, although a considerable number of small fragments of lead remained in the patient's lung tissue (*Fig.* 211).

The need for an opening in a dependent position, to allow of free escape of the discharges, appears to us to be indisputable. The larger the opening, the better will the drainage be, and also the probability of a rapid and uneventful convalescence. Resection of one or two segments of the ribs at the site of the incision greatly facilitates and hastens the reparative processes within the pleura, and also tends to prevent the formation of those persistent fistulæ which are so often seen.

These principles apply equally to the technique of pleurotomy for empyema (see later).

II.—THORACO-ABDOMINAL WOUNDS—WOUNDS AND RUPTURES OF THE DIAPHRAGM.

Injuries affecting the base of the thorax and the hypochondriac regions, involving both chest and abdomen, may produce very serious conditions, which require special consideration. (See also Wounds of the Abdomen, Wounds of the Liver and Spleen).

In practice, three possible conditions may present themselves:—

1. **A stab wound at the level of one of the lower intercostal spaces, the wound being of considerable size and omentum protruding from it, having evidently passed through the diaphragm.** A case recorded by Walther will serve as an example: the wound occupied

the 7th and 8th left intercostal spaces, and was the seat of a large omental hernia; the herniated mass was ligated, resected, and reduced through the perforation in the diaphragm: through the same opening a finger was introduced into the abdomen, and found that the stomach was uninjured. The diaphragm was sutured and the wound in the thoracic wall closed. Healing took place without any complication.

In such a case the route to be followed is clearly indicated; at times, however, a decision may be attended with considerable difficulty.

Begin by *enlarging the thoracic wound* if access is in any degree restricted; abundant room is necessary for the reduction of the omental hernia, the examination of the subdiaphragmatic viscera, and the closure of the wound in the diaphragm. Resect, at once, a large segment of the rib immediately below the wound. Then separate the margins of the wound with two large retractors, and examine the intrathoracic area with the aid of a good light; clear away the blood and clots; you will then be able to determine the seat and the characters of the diaphragmatic perforation.

If it occupies the outer sloping surface of the diaphragm, not far from its costal attachment, the parietal opening just made will, as a general rule, be sufficient for anything that has to be done. If, however, it is more deeply and less accessibly situated towards the summit of the diaphragm, do not hesitate to enlarge the external wound by removing a portion of the rib immediately above it. If the diaphragmatic lesion is anteriorly placed and more room is required, resect the cartilaginous thoracic margin; if it is situated behind, cut an osteoplastic flap with the base upwards.

There can be no doubt that by the transpleural route we have just described, a diaphragmatic wound is more easily accessible and more easily exposed; further, a thoracic epiplocele may be more easily treated and reduced and the diaphragm more easily sutured than by way of the abdomen, at the bottom of one or other hypochondrium. This method has, however, one serious danger, viz., the difficulty of recognizing and treating the possible abdominal lesions—perforations of the stomach or intestine, or wounds of the liver or spleen—through an opening in the diaphragm.

Pull the herniated omentum a little farther out into the wound, and resect it, after applying interlocking ligatures to the base of the mass; cleanse the stump carefully, and then replace it gently in the abdomen.

As soon as the omental plug which has been occluding the opening in the diaphragm has been displaced, blood may be seen beginning to flow in abundance from the wound, indicating some more deeply-seated lesion. If there is no bleeding, introduce a finger through the diaphragm and explore the subjacent region; examine the stomach as far down as possible, and the liver. If nothing suspicious is found, and the finger when withdrawn is not blood-stained, then suture the diaphragm. For this purpose use a long-handled, full-curved needle, pick up as much as possible of the muscle on either side of the wound, and tie the sutures one by one as they are passed.[1] If there is a gastric or colic perforation, it will be possible

[1] If the wound occupies the vertical portion of the diaphragm, it will be simpler and more expeditious to suture its edges to the thoracic wall, as Walther did in the case already quoted (*Soc. de chir.*, 16 Jan., 1901, p. 30).

to suture it by the thorax, after having drawn the wounded viscus through the diaphragmatic opening—enlarged if necessary. It is the same also with regard to wounds of the convex surfaces of the liver or spleen.

In twenty-three cases of transpleural operation for wounds of the diaphragm, analysed by Ch. Lenormant, the stomach was sutured in three and the liver in four.[1]

The choice of method depends in fact on the seat and extent of the subdiaphragmatic visceral lesions. By the upper route, more direct access is obtained to the convex surface of the liver, to wounds of the posterior surface of the stomach, and to those in the neighbourhood of the cardiac extremity; but if exploration through the diaphragm is at all difficult or uncertain, or if the internal hæmorrhage is profuse, it will be well to open the abdomen without loss of time by a median incision above the umbilicus, extended if need be by an oblique cut along the costal margin. Once the intra-abdominal portion of the work is finished, the thoracic opening, which had been left open, will be used for suturing the diaphragm.

Case 13.—A man, 22 years of age, had received a knife stab in the left side: treatment in the first instance was limited to simple suture of the superficial wound. Six hours later the patient showed signs of serious internal hæmorrhage; on the left side of the chest, from the 8th to the 10th rib, there was a swelling, the centre of which lay directly behind the sutured wound. The sutures were removed, the blood and clots cleared out, and omentum was discovered. After resection of portions of the 9th and 10th ribs, the finger, following the protruded omentum, passed into the pleural cavity, and from there, through a gap in the diaphragm, into the abdominal cavity. At this moment a profuse hæmorrhage occurred. The abdomen was immediately opened along the outer border of the left rectus. A wound of the anterior wall of the stomach, bleeding freely, was found and sutured in the ordinary manner. The wound in the diaphragm, which was about two inches long, was in its turn closed by interrupted sutures, picking up the whole thickness of the muscle (Borsuk[2]).

2. **Gunshot Wound, the External Wound being small.**—In such an injury the external examination gives no indications of the nature of the deep lesions, and the surgeon must be guided altogether by the symptoms in considering the question of abdominal penetration. Later, we shall study the indications for laparotomy in gunshot wounds of the abdomen (see

[1] Ch. Lenormant, "Du traitement opératoire des plaies du diaphragme." *Revue de chirurgie*, 10 mai, 1903, No. 5, p. 617. In the 23 operations by the transpleural route there were only 3 deaths (13 per cent), while the 8 operations by the abdominal route were followed by 5 deaths (62·5 per cent). In 73 cases of operation for wounds of the diaphragm collected by M. A. Suter, 54 were performed by the transpleural, 12 by the abdominal route, and 7 by the two routes combined; of the 73 patients, 64 recovered and 9 died, a general mortality of 12·3 per cent: for the transpleural operations, however, it is only 5·6 per cent: for the laparotomies it rises to 33·3 per cent, and to 25 per cent for the combined operations. It is to be noted, however, that operation has been undertaken by the abdominal route or by the combined abdominal and thoracic routes in the most serious cases, those complicated by lesions of the abdominal viscera; still, in 12 transpleural operations in which lesions of the stomach, the colon, the liver, the spleen, or the kidney, had to be treated, there was only one death. In fact, statistics prove that the transpleural route is always to be preferred when practicable. (A. Suter, "Ueber die operative Behandlung von Zwerchfellwunden." *Beitr. zur klin. Chirurgie*, 1905, xlvi., 2, p. 341).

[2] M. Borsuk. *Medycyna*, 1893, No. 17. The case is interesting from the point of view of surgical technique: unfortunately operation was undertaken too late, the patient dying from the results of the loss of blood ten hours later.

WOUNDS OF THE ABDOMEN); here we shall simply mention that *epigastric rigidity*, pain and tenderness, progressive abdominal distention, and vomiting of blood are the diagnostic points of greatest significance in these cases.

In operating, the abdominal route is to be preferred as a rule:[1] a median incision above the umbilicus, combined, if access is insufficient, with a second incision from the upper end of the first, running downwards and outwards along the costal border, and possibly with excision of part of that border. Indeed, as Auvray[2] has pointed out, a wound of the stomach is often situated very high up, not far from the cardia, and to allow of the necessary manipulations at such a depth plenty of room is essential.

If dealing with a bullet wound, the diaphragmatic perforation will often be difficult to find, and equally so to close; in face of serious difficulties it is better not to persist too long, though it must not be forgotten that even a small perforation may form a track for a subsequent diaphragmatic hernia.

Further, there is no necessary relationship between the size of the wound in the thoracic wall and that in the diaphragm, and even when the wound of entry is quite small the laceration in the diaphragm may be large enough to allow the passage of a hernia, which becomes strangulated, producing another group of symptoms and operative indications. (See later, DIAPHRAGMATIC HERNIA).

3. **Ruptures of the Diaphragm.**—These injuries are caused by sudden compression of the base of the chest, by falls from a height, and by crushes; they are often complicated by other lesions, and too often they are only recognized at the autopsy.

The diaphragm may, however, be affected alone, simply fissured or ruptured over a variable extent, particularly on the left side; the stomach, transverse colon, or omentum may pass into the opening, and not uncommonly the hernia at once becomes strangulated. Under such conditions, the initial symptoms directly due to the injury—shock, dyspnœa, signs of internal hæmorrhage—are speedily associated with indications of *intestinal obstruction*. Sometimes, at least when the diaphragmatic hernia is very

[1] As the first step, or as soon as it has been determined by an incision made at the site of the external wound that the perforation of the diaphragm is inaccessible or so small that any satisfactory exploration of the abdomen from above is out of the question.

[2] AUVRAY, "Plaies pénétrantes de l'espace de Traube. Plaies de l'estomac." *Congrès français de chirurgie*, 1899. One of the cases related by Auvray was that of a child aged 15 years, who had received a stab with a narrow-bladed knife in the 7th left intercostal space outside the nipple line, in the region which corresponds to Traube's space. Seven hours after the accident there was very definite rigidity of the abdominal wall above the level of the umbilicus, which, notwithstanding the absence of any other signs, seemed sufficient to justify a diagnosis of some deep visceral lesion. Laparotomy was therefore performed. "While pulling down the stomach," writes Auvray, "I heard a gurgling noise, and some gas escaped from the abdominal cavity. Fairly high up on the anterior wall of the stomach I found a perforation about the diameter of the tip of the little finger, through which the mucous membrane was protruding." The opening was closed by a double layer of fine silk sutures. The posterior surface of the stomach was then examined through an opening made in the gastro-colic omentum, but no lesion was discovered. The wound in the diaphragm was closed. The upper part of the abdomen was cleansed by swabbing, and the sub-hepatic region packed with gauze. Next day, the existence of a left-sided pneumothorax was noted, which, however, disappeared without causing any trouble, and the patient recovered.

large, certain special physical signs may be detected: the heart may be displaced to the right, and the apex found close to the sternum, pushed over by the herniated mass of viscera, as it would be by an extensive pleural effusion; further, the base of the thorax and the lowermost intercostal spaces are distended, and all over the area confused murmurs are heard, quite different from the ordinary pulmonary sounds.

In such a case operation should be performed by the transpleural route, by opening the 8th intercostal space and resecting the 9th and if need be also the 8th rib, over a sufficient extent. The technique to be employed in dealing with these traumatic herniæ is identical with that which we shall describe in another chapter, for strangulated diaphragmatic hernia. (See HERNIA.)

III.—WOUNDS OF THE PERICARDIUM AND HEART.

Let us say first of all that the seat of a wound in the precordial region is by no means always an indication of a pericardial or cardiac lesion; revolver shots "fired at the heart" in suicidal attempts are sometimes followed only by a little localized emphysema, a moderate effusion, and some quite temporary symptoms.

When the heart is actually affected, death is sometimes so rapid that there is no time to attempt anything. But these cases are far from being always fatal;[1] in a large proportion there is a place for immediate surgical intervention, as is shown by the increasing number of successful operations now on record.

What then are the operative indications after injuries of the heart and pericardium? What are the ways of approach to the pericardium and the heart? What are the technical methods to be followed in bringing these cases to a successful issue?

(*A*). **Indications for Immediate Operation.**—With the seat of the wound, **hæmorrhage, external or intrathoracic,** is the commonest of the indications. The blood may escape from the precordial wound in pulsating jets, or it may run in a continuous stream which no occlusion of the wound or compression succeeds in checking. More often, however, the hæmorrhage is internal, and the pleura having been wounded along with the pericardium, the blood flows into the pleural cavity, producing the signs of a *steadily increasing hæmothorax*, along with symptoms of acute anæmia and progressive dyspnœa. The situation is much the same as after the serious pulmonary traumatisms of which we have already spoken, with this difference, however, that the trouble is often more intense and the indications are more urgent.

When there is a large wound in the pericardium and the neighbouring pleura is also opened, a free way of escape for the effused blood is provided, and consequently symptoms of cardiac compression are much less marked

[1] In G. Fischer's statistics, comprising 452 cases, there were only 104 immediate deaths. (*Arch. f. klin. Chir.*, 1868, Bd. ix., p. 571).

than in those cases where, because of the small size of the pericardial perforation, or because of its elevated position, near the base, the blood cannot get away, but accumulates around the heart, forming a hæmopericardium with rapidly increasing tension.

The heart is then compressed within its fibrous sheath (Rose's *Herztamponade*), and very grave functional disturbances quickly appear. These are usually very definite, and are combined with such easily recognizable physical signs that there can be no doubt as to the nature of the condition or any justification for hesitation or delay. The pulse becomes very feeble and very fast; the cardiac distress, the cyanosis, and the venous distention indicate the compression of the auricles; at the same time, the apex beat can no longer be felt (or perhaps slightly, if the patient is in a sitting position), the heart sounds are dulled, distant, and scarcely perceptible; the cardiac region is occupied by a triangular area of dullness with its base downwards, extending over the lower half of the sternum and the 4th, 5th and 6th spaces for 4 or 5 inches from the left margin of the sternum: it may even extend beyond these limits in a downward direction by displacement of the diaphragm; quite often a more or less extensive bulging of the thoracic wall also indicates the progressive distention of the pericardial sac.

In face of these signs, no doubt can exist; it is urgently necessary to open the pericardium in order to evacuate the abnormal contents, to liberate the heart, and if possible to stop the bleeding.

Whatever may be the necessity for acting quickly, the usual aseptic "preparation" must neither be neglected nor curtailed; it is to be remembered that septic infection[1] is a very frequent cause of death after operations of this kind.[2]

(*B*). **Ways of Approach to the Pericardium and Heart.**—The point which is of more importance than any other is to expose the pericardium and the heart very freely, and to do this it is necessary to have definite ideas with regard to the ways of approach and the opening to be made.

From a practical point of view, the **accessible region** of the pericardium corresponds to the 4th, 5th, and 6th intercostal spaces, from the border of the sternum to a distance of three or four inches outwards.

In this area, between the skin and the pericardium, the following structures are found from before backwards: the inner fibres of the pectoralis major, the 4th, 5th, 6th, and 7th costal cartilages, with the intervening intercostal muscles, the internal mammary artery, which descends vertically behind the cartilages, a finger's breadth from the

[1] M. Guibal has remarked with good reason that 45 per cent of the deaths after operation are due to pleuro-pericardial infection, and that a large proportion of the recoveries have been compromised and retarded by septic complications. ("La chirurgie du cœur." *Revue de chirurgie*, 1905, t. i., pp. 323, 623, 761; t. ii., pp. 245 and 369.)

[2] A little further on we shall speak of wounds of the heart complicated by the presence of foreign bodies, and in dealing with pericardiotomy shall give the indications for secondary operations, rendered necessary by infection of a hæmopericardium.

sternum, the triangularis sterni, the costo-mediastinal pleural cul-de-sac,[1] which usually extends to the sternal border, and a process of the left lung, which is however, very mobile, and rarely appears in the field of operation. To make a simple intercostal incision in, say, the 5th space, is to commit oneself to a blind, difficult, and therefore dangerous search. It is absolutely necessary to resect or turn back a flap containing one or more ribs.

In a large number of the recorded cases, a longer or shorter segment of the 4th, 5th, or 6th rib has been excised, and naturally the situation of the wound and its direction, when large, have been important factors in determining the position of the first step. It is always a good plan to take the external, visible, and material sign (the wound) as a guide, but it would be wrong to make this an absolute rule, for the correlation of the superficial and deep lesions is by no means constant. Abundant room is necessary if the operation is to be carried out quickly, and in order to avoid unnecessary and irreparable mutilation of the thoracic wall, it is advisable to have recourse to a systematic thoracotomy[2] in the first instance.

The flap with external base, recommended by Fontan,[3] is very satisfactory: by its means he has been able on two occasions to suture with success penetrating wounds of the left ventricle. It has its centre at the nipple, and contains the 4th, 5th, and 6th ribs if the wound is low, the 3rd, 4th, 5th, and 6th if it is high, and the base is towards the axilla.

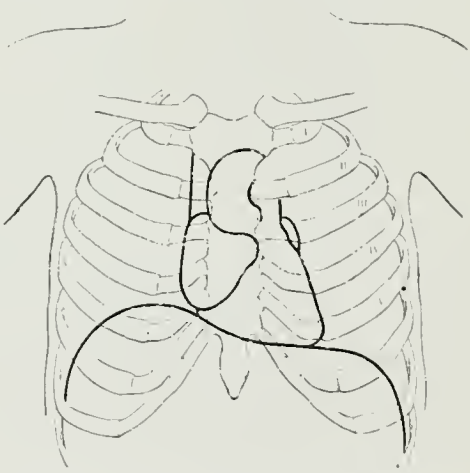


Fig. 212.—The heart, the diaphragm, and the origin of the great vessels, projected on the thoracic wall (Terrier et Reymond, *loc. cit.*, p. 112, *Fig.* 35.)

Make a horizontal incision over the 6th space, beginning externally close to the anterior axillary line (about 4 in. from the sternum); prolong it inwards to the left border of the sternum, along which it is then carried vertically upwards to the level of the 4th or 3rd costal cartilage, across which it runs obliquely, to end in a horizontal limb over the 3rd or 2nd space, thus forming a large U-shaped flap. Divide the skin and superficial muscles at once, and

[1] Adherent to the triangularis, only slightly adherent to the pericardium, from which it is easily separated, as we shall see presently.

[2] The methods employed are very varied. For a complete description see the report by Terrier and Reymond. "Chirurgie du cœur et du péricarde." *Congrès français de chirurgie*, 1901.

[3] Fontan, "Plaie du cœur, suture du ventricule gauche, guérison" (*Bull. de la Soc. de chir.*, 9 mai, 1900, p. 492). A second case (*Bull. de la Soc. de chirurgie*, 27 nov., 1901, p. 1090). The first patient recovered, the second died five months after.

expose the upper and lower limiting ribs, the sternal border, and the chondro-sternal articulations (*Fig.* 213).

Then, following the advice of Terrier and Reymond, look for the cartilaginous bridge connecting the 6th and 7th costal cartilages (*Fig.* 214); take the elevator and free the segment of the 6th cartilage which extends from this bridge to the sternum, divide its extremities with strong scissors, and remove it. Introduce the end of the finger through the opening thus made, and on it as a guide pass an elevator under the bridge, free its deep surface, and cut it; then passing upwards under the 5th, 4th, and 3rd cartilages in turn, separate them from the subjacent soft parts, and divide them close to the sternum. The flap is now free on the *inner side;* it still remains to liberate it above and below, to separate it from the underlying structures, to form the hinge, and to turn it back.

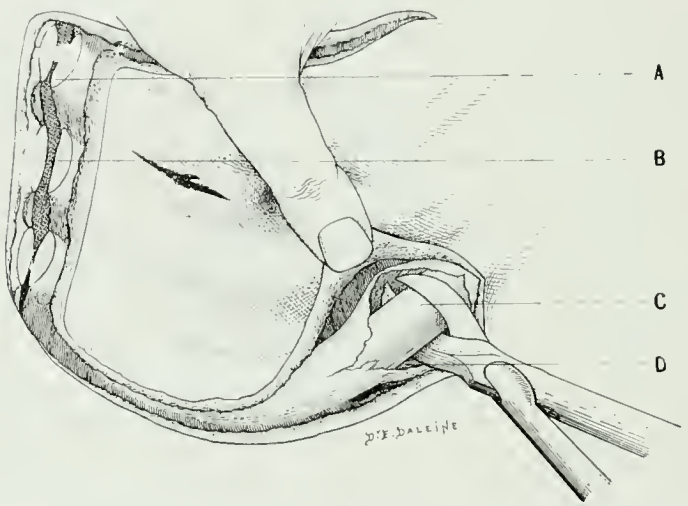


Fig. 213.—Precordial osteoplastic flap with external base (Fontan). 1st step, cutting the flap. (A) 4th costal cartilage, divided. (B) sternal extremity of the 5th cartilage. (C) dividing the 6th rib. (D) periosteum and vessels stripped from the lower border of the rib.

Divide the intercostal tissues in the spaces above and below, at the limits of the flap, then raise the inner border of the flap as high as possible and strip the pleura and the pulmonary border from its deep surface with a piece of gauze, and push them as far out of the way as possible.

Often the pleura has been traversed and opened by the wounding body, and you penetrate at once into the pleural cavity, full of blood and clots. Remove the clots, dry out the cavity as quickly as possible, and apply temporary forceps to the pulmonary border if it has been wounded and is still bleeding.

At the external extremity of the lower horizontal limb of the incision, expose the 6th rib in the manner depicted in *Fig.* 213, incise the periosteum, and separate it from the lower border of the rib, which is then divided with

bone-cutting forceps. The upper limiting rib is then divided in the same manner. The intermediate ribs still remain to be dealt with; they are simply broken by pressing with one thumb on the outer surface, while the other hand forcibly raises the flap in one piece. The pleura may now be separated as far as is necessary, covered with a fold of gauze, and retracted outwards along with the base of the flap (*Fig.* 215).

By this method, the left ventricle, a large part of the right ventricle, and the left auricle are exposed (*Fig.* 212). If access is still insufficient, and in particular if it is necessary to expose the right auricle, more space can be provided by continuing the two horizontal limbs of the incision across the front of the sternum, dividing the bone from left to right, along the lines of the superficial incisions, with the chisel, after separation of the soft tissues from its deep surface; the sternal flap can then be raised and partially turned to the right, a hinge being formed by bending the right costal cartilages attached to it.[1]

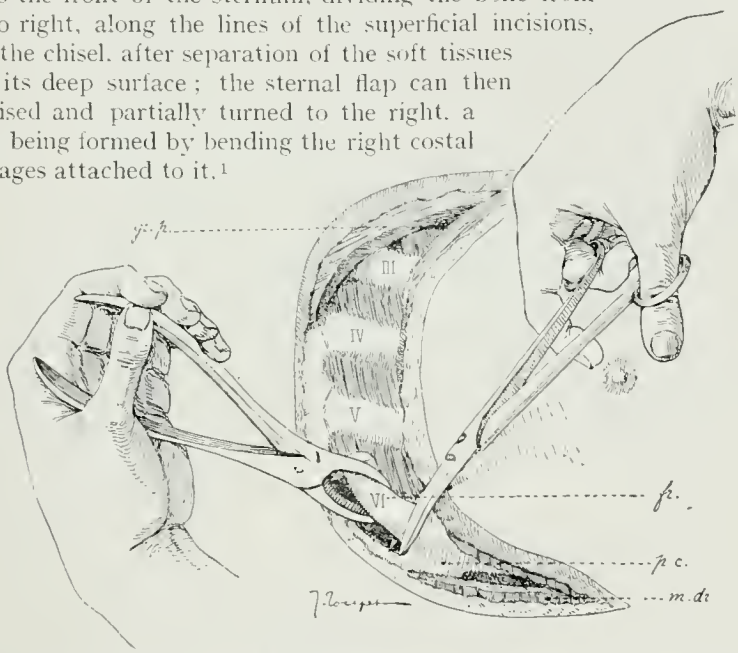


Fig. 214.—Precordial osteoplastic flap with external base. Division of the cartilaginous bridge between the sixth and seventh ribs. *fr*, cartilaginous segment situated between the sternum and the cartilaginous bridge *pc*; it is cleared, then removed by two cuts of the scissors. *gr.p.*, pectoralis major. *m.dr.*, rectus abdominalis. (Terrier et Reymond, *loc. cit.*, p. 77, *Fig.* 25.)

Rotter's flap with internal hinge[2] gives less room, but it can be very rapidly fashioned, and although much inferior to the foregoing as a general method, it deserves to be mentioned, at least for large wounds situated at some distance from the sternal border and manifestly involving the pleura.

[1] Terrier et Reymond, *loc. cit.*, p. 84. This could only be necessary, however, under very exceptional circumstances, and further, though one need not lay undue stress on the excessive amount of interference with the sternum which is involved, still it is to be remembered that any procedure which requires transverse section of the sternum possesses considerable technical difficulties. In the case of a wound situated to the right, it might be advisable to cut a second flap with external base on that side in the manner above described: it would give access to the right side of the heart, the upper part of the right ventricle, and the right auricle (Fontan, *loc. cit.*).

[2] Rotter, *Munchener med. Woch.*, 1900, No. 3, p. 79.

The flap is marked out by a large U-shaped incision, open inwards. The upper horizontal limb of the incision, 4 in. long, commences $\frac{1}{2}$ in. from the left border of the sternum and runs outwards along the lower border of the 3rd rib; the lower horizontal limb, about 3 in. long, runs along the lower border of the 5th rib; the vertical limb joins the two outer extremities of the others, and passes to the inner side of the nipple (*Fig.* 216).

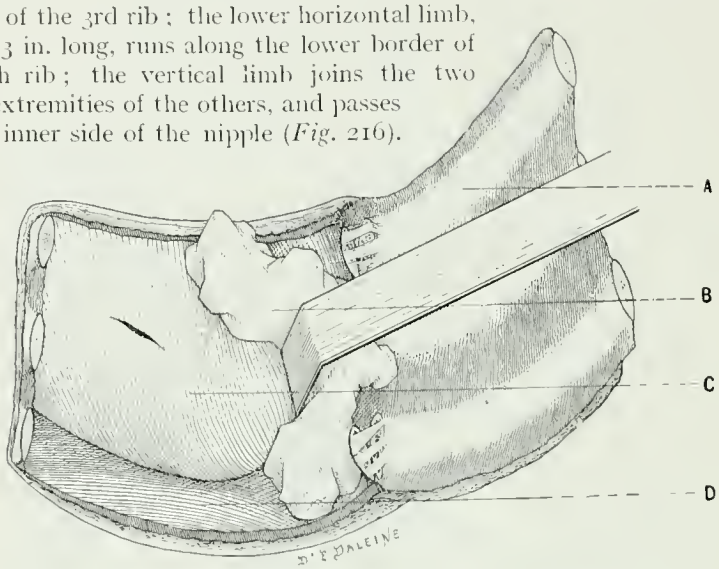


Fig. 215. – Precordial osteoplastic flap with external base (Fontan). 2nd step, turning back the flap. (A) Rib turned back. (B) Gauze covering the anterior border of the lung and closing the opening in the pleural (C) Wounded pericardium. (D) Diaphragm.

The 4th and 5th ribs are divided at the outer limit of the flap, and the thoracic parietes cut in the line of the superficial incision; the flap is then

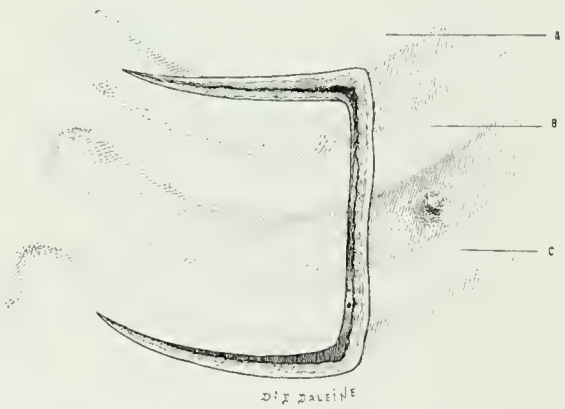


Fig. 216.—Precordial osteoplastic flap with internal base (Rotter). 1st step, Cutting the flap. (A) Third rib. (B) Fourth rib. (C) Fifth rib.

turned back across the front of the sternum by dislocating the 4th and 5th chondro-sternal articulations (*Fig.* 217).

The internal mammary artery remains intact, the 4th and 5th intercostals are tied, and the pleura and lung are pushed out of the way under a fold of gauze.[1]

(*C*). **Treatment of the Pericardium and the Heart.**—The pericardium being exposed, look for the wound, the perforation from which the blood is coming, and enlarge it longitudinally: clear away the effused blood, and examine the heart.

If there is much blood in the pericardial sac, it is almost certain that the heart is injured; but the wound in the pericardium and that in the

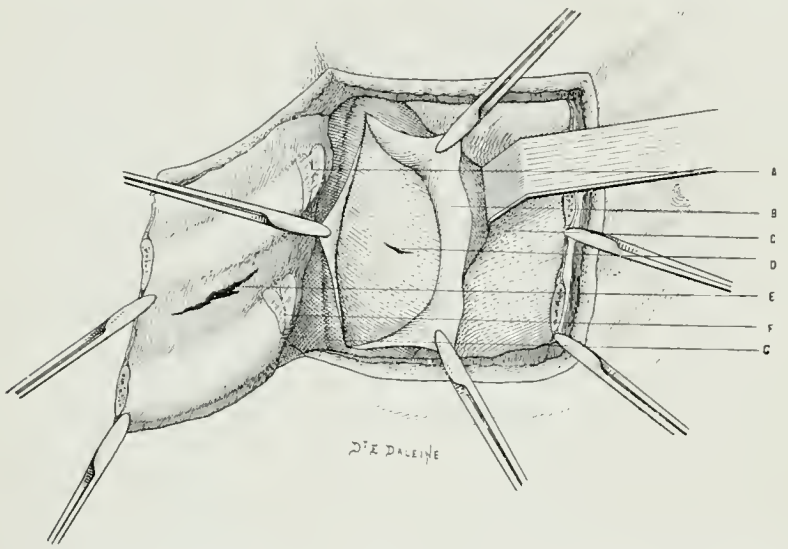


Fig. 217.—Precordial osteoplastic flap with internal base.(Rotter). 2nd step, the flap turned back. (A) Fourth costal cartilage, dislocated. (B) External edge of the pericardial incision. (C) Pleural cul-de-sac and anterior border of the lung, retracted. (D) Wound of the heart. (E) Wound in the thoracic wall. (F) Fifth costal cartilage, dislocated. (G) Track of the internal mammary artery.

heart are not by any means always in line. Do not hesitate to enlarge the opening in the pericardium freely, so that the heart may be seen clearly and examined carefully with eye and finger.

Some non-penetrating cardiac wounds may heal spontaneously or may pass unperceived, but under such circumstances hæmostasis is uncertain, and after an operation limited to the pericardium, the cardiac wound may give rise to serious secondary hæmorrhage or may form the site of a subsequent rupture.

If nothing is found but a *narrow fissure of the myocardium* which is no longer bleeding, one may, if nothing better can be done, trust to

[1] The flap might be made of greater vertical extent, one or two more ribs being resected: in any case there will be some difficulty at the inner border. But for wounds of the lung a flap of this kind will sometimes be useful (see p. 229).

spontaneous closure; but in any case, if it is accessible, it is much better to suture the wound.

When that is done, or if no cardiac lesion has been found, and if, after the pericardium has been carefully dried out, no more bleeding appears, you will finish by suturing the wound in the wall of the sac, the two edges being approximated by their serous surfaces.

But suppose that, after opening up the pericardium, a perforating wound of the heart is found, from which a jet of blood escapes at each systole.[1] Forceps must not be trusted to for temporarily closing the wound and fixing the organ. Place the tip of the right index finger on the bleeding point, into the gaping fissure if necessary, and, without loss of time—because the movements of the heart render the hæmostasis thus obtained very incomplete—introduce the left index and middle fingers into the widely opened pericardium, under the apex of the heart and up behind it, and bring the organ forward to the opening in the pericardium, in such a manner that the cardiac wound presents in the pericardial opening, while the cardiac surface surrounding the wounded area is gently compressed against the deep surface of the pericardial wall; if necessary, the whole hand may be introduced, the heart being grasped in the palm, and dislocated outwards (*Plate IV*).

The records of many cases prove that these methods are perfectly legitimate, and they constitute the best means of controlling dangerous hæmorrhage, of exposing the wound,[2] and of facilitating suture.

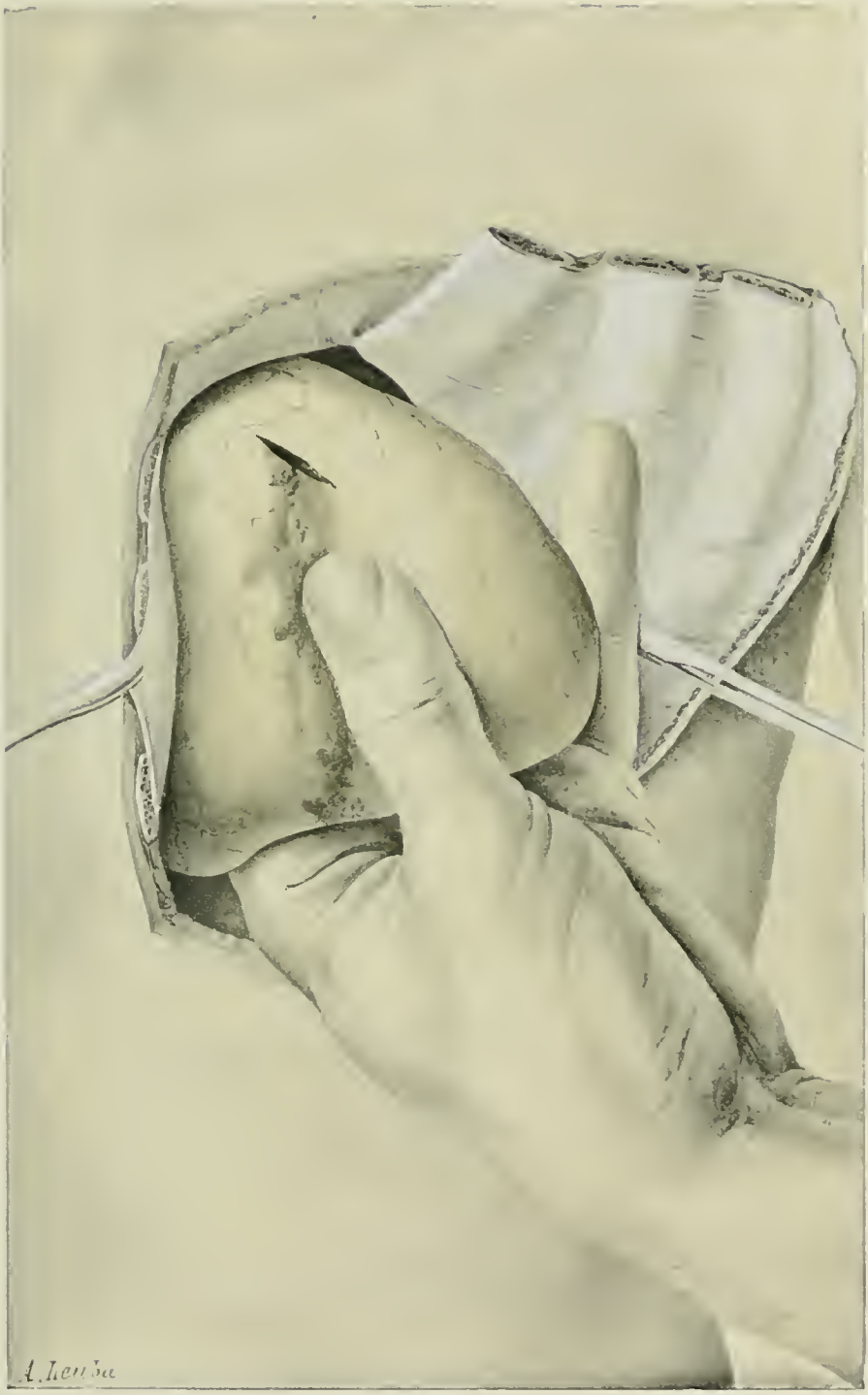
The great difficulty in suturing a wound of the heart depends on the extreme mobility of the organ, and not only on its own proper but considerably accelerated systolic and diastolic movements, but still more on the vertical, irregular, and disorderly movements due to respiration and the jerky action of the diaphragm. During expiration the heart is drawn upwards towards the retracted lung, and tends to slip away from the operator; it ought therefore to be grasped during inspiration.

It is impossible to lay down any precise rules with regard to the application of the sutures. It may be true that the favourable moment for passing the thread is during diastole, because the cardiac wall is then more easily and consequently more rapidly penetrated. Practically *you must do what you can.*

The first suture always causes the most difficulty; it must be passed very quickly. A single point is sometimes sufficient. If the wound is of some length, begin at one of its extremities; use a fine, round-bodied, full-

[1] Wounds of the ventricles are the more common; out of 78 cases of injuries of the heart by sharp instruments, collected by E. Loison ("Des blessures du péricarde et du cœur et de leur traitement," *Revue de chirurgie*, 1899, p. 48), the right ventricle was affected in 31, the left ventricle in 25; out of 94 cases of gunshot wounds the left ventricle was involved in 38, and the right ventricle in 18. Amongst the 66 cases of cardiac suture collected by M. Guibal (*loc. cit.*) the left ventricle was affected in 31 (46·9 %) and the right ventricle in 22 (33·3 %), the apex in 7, the right auricle in 2, the left auricle in 2, the interventricular groove in 1, the coronary artery alone in 1.

[2] If nothing is seen on the front of the heart, the apex is raised and inclined to the side, so that the borders and the posterior surface may be examined. In cases of gunshot injuries there are sometimes two wounds.



THE HEART HELD IN THE PALM OF THE LEFT HAND
FOR SUTURE OF A WOUND

curved needle, mounted at a right angle in a needle-holder (or a curved Reverdin needle); pass the sutures from side to side of the wound as deeply as possible through the myocardium, but taking care not to perforate the endocardium. The sutures should include at least a sixth of an inch of tissue on either side of the wound, to insure against their cutting out when tied.

In this way two, three, or four sutures may be passed if necessary to render the suture line blood-tight. Interrupted suture has been most often employed, and appears to be the least difficult to execute; when the first point has been passed and tied, the ends left long serve as a tractor to facilitate the introduction of the others (see *Fig.* 218). Fontan has used a continuous suture (*Figs.* 218 & 219), and in order to assure complete approximation of the wound edges, has combined with it a "returning" continuous suture, the loops of the second crossing those of the first at right angles, as shown in *Fig.* 219. This is undoubtedly an excellent method for obtaining hæmostasis and absolute occlusion of the wound; but as we said before, it is impossible to formulate definite rules: provided that the lips of the wound are accurately and firmly brought together, the type of suture matters very little. Indeed, it does not seem that there has been any particular difficulty in obtaining satisfactory closure of the wound: death after operation has hardly ever been due to bleeding from a badly sutured or secondarily separated cardiac wound; at the autopsies the wound edges have almost invariably been found firmly adherent.[1]

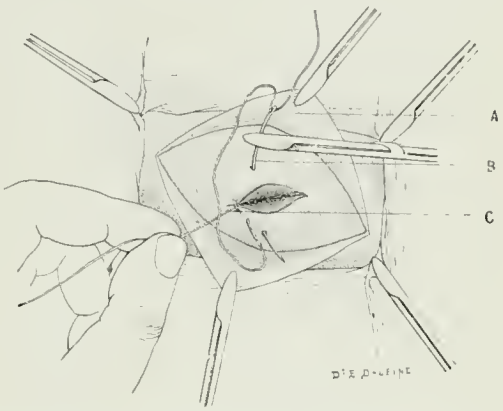


Fig. 218.—Closure of a wound of the heart (ventricle) by a continuous suture. (A) Pericardium opened and retracted. (B) Needle picking up the whole thickness of the myocardium. (C) First turn of the suture, knotted; the free end is left long and is being used as a traction thread.

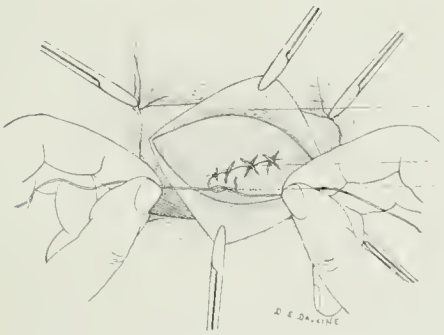


Fig. 219.—Closure of a wound of the heart (ventricle) by a continuous suture. (A) Pericardium opened and retracted. (B) "Returning" suture. (C) Terminal end of the suture being knotted with the first end.

[1] Four heart sutures have been performed in my hospital service during the past two years by my residents, MM. Lemaitre and Guénot: three of the patients survived for several days, and in each case at the autopsy the wound was found firmly united.

Which is the best suture material, catgut or silk? Fine catgut, if very strong and very pliable, may be used with advantage, as its ultimate absorption obviates the persistence of a foreign body in the wall of the heart; otherwise fine silk or linen thread is to be preferred.

After the cardiac wound is closed, the pericardial cavity must be carefully cleansed and dried with sterile gauze, without any irrigation, and then the wound in the wall of the sac will be completely closed without drainage, which should be reserved for the late operations in which there is reason for suspecting the existence of pericardial infection.

The pleural focus is in its turn cleansed by dry gauze swabbing; if there is a wound of the anterior border of the lung, it will be sutured; if satisfactory hæmostasis is obtained, and the injury is a recent one, there is no indication for pleural drainage, and the thoracic flap is replaced and carefully sutured all round.

If, however, oozing from the pulmonary wound still persists, a gauze drain should be placed in the pleural cavity, and the end brought out at a corner of the wound; if the hæmothorax is some days old, and infection is certain or even probable, a drainage tube should be placed in the pleura and brought out at the lower border of the flap, or, better still, by a separate opening below and behind, at the level of the 8th or the 9th rib.

There are no operations which require more decision and presence of mind than those performed for cardiac injuries; as examples, we shall quote a case of Rehn's (the first recovery) and one of Fontan's.

Rehn's patient,[1] a gardener, aged 22, had received a stab wound in the 4th left intercostal space, about two inches from the sternum; at that point there was a wound $\frac{3}{4}$ in. long parallel to the ribs. It was only on the third day, because of aggravation of the symptoms and the detection of signs of a rapidly increasing hæmothorax, that Rehn operated.

An incision 5 in. long was made over the 4th left intercostal space. The 5th rib was divided a little to the inner side of the nipple line and doubled inwards around its sternal attachment. Some dark blood escaped, and the finger introduced into the wound penetrated into the pleural cavity and came in direct contact with the pericardium. The internal mammary artery was not injured. The pleura was freely opened up, and a quantity of dark blood and air escaped. The administration of the anæsthetic was then suspended.

The pericardium was well exposed, and a small perforation, from which dark blood ran in a continuous stream, was readily perceived. In order to draw it into the wound the pericardium was seized with forceps, but it tore, and it was only after the margins of the perforation had been excised that tissues were reached which would hold the forceps. A large part of the cardiac surface was exposed, and its movements in the dilated pericardium were extraordinary; some blood clots were evacuated from the depths of the cavity. During diastole a wound of the right ventricle could

[1] Rehn, "Ueber penetrirende Herzwunden und Herznaht" (*Arch. f. klin. Chir.*, 1897, Bd. lv., p. 315).

be seen ; it was about $\frac{3}{4}$ in. long, situated close to the middle of the ventricle, and its borders were well defined and gaping. It gave issue to a jet of blood, which appeared to be altogether diastolic, and was checked by pressure with the finger.

Suture was undertaken with the aid of a fine intestinal needle and a silk thread. At the beginning of a diastole, the needle was rapidly and deeply passed at the left angle of the wound. It seemed that the diastolic stage was somewhat prolonged. During the next diastole the suture was tied, and again the heart seemed to slow down. Once the first suture was tied the bleeding diminished. The application of the second suture was greatly facilitated by traction on the ends of the first ; but it was very alarming to see the heart stop in diastole at every step. After the completion of the third suture, which was placed with great difficulty owing to the movements of the heart, the hæmorrhage stopped altogether. The pleura and pericardium were drained with strips of gauze ; the costal segment was replaced, and the soft parts were sutured.

The results of the operation were very remarkable : the respiration rate fell from 76 to 48, and in the hours immediately following to 34, 32, 28 ; the pulse ranged from 112 to 132 and varied in strength. After some trouble due to pleural infection, the patient recovered.

Fontan[1] operated six and a half hours after the receipt of the injury. The patient, was a soldier a morphinomaniac, who had given himself six stabs with the point of a scissors blade in the precordial region. The large flap shown in *Figs.* 213, 214, and 215 was rapidly cut and turned towards the axilla ; the pleura was found to be full of dark blood and clots, which were cleared out. Several lesions were then discovered : a wound of the diaphragm, which did not appear to be penetrating ; a wound of the anterior border of the lung, which was seized and closed with two or three pairs of forceps ; a wound about $\frac{1}{3}$ in. on the pericardium, from which blood was escaping into the pleural cavity. The pericardium was at once opened up with scissors for a length of 2 in., and the edges of the incision were secured with forceps. The sac was full of blood, and the finger exploring the heart detected a wound of the left ventricle, $1\frac{1}{2}$ in. above the apex. After this had been cleansed and brought well into view, the wound was found to be $\frac{1}{2}$ in. in length ; it lay transversely, and at each systole a jet of blood escaped. The inner commissure of the wound was caught with toothed forceps, and with very great difficulty a first suture of catgut was passed with a medium-sized Hagedorn needle ; after the suture was tied, the free end served as a fixation thread during the passage of two other loops of a continuous suture, running from within outwards and also from before backwards, the wound being situated on an obliquely placed surface. The bleeding was now completely arrested ; nevertheless a second "returning" suture was introduced, using the same thread, in such a manner that the loops of the second crossed those of the first at right angles. The suture was finished off by tying the two ends together (*Figs.* 218, 219). The pericardial cavity was cleansed with boiled water. The pericardial and

[1] Fontan, *loc. cit.*, Première observation.

pulmonary wounds were sutured with catgut; the flap was replaced, and the wound completely closed without drainage. The wound healed by first intention, and the patient made a straightforward recovery.

Successful cases of suture of cardiac wounds are no longer uncommon: in 66 cases[1] collected by M. Guibal[2] there were 26 recoveries (39·3 per cent) and 40 deaths (60·7 per cent).

Foreign Bodies embedded in the Heart.—These are most frequently needles, of different sizes. The head of the foreign body, implanted in the precordial region, may be seen or felt more or less definitely, and may oscillate in unison with the cardiac movements. This rhythmical oscillation may indicate simple contact with, or actual penetration of, the heart. An effort to remove it should be made at once.[3]

If the foreign body is of quite small diameter, if the end is exposed and sufficiently projecting, grasp it firmly with forceps and withdraw it slowly by steady traction without any jerking; most frequently it will first of all be necessary to make an incision over the apparent extremity, or better, as René Le Fort has advised,[4] an incision a little above or below that extremity, sufficiently deep to allow of the body being disengaged over a certain length and safely grasped; otherwise there is some risk of pushing it in and losing it during the attempts at extraction.[5]

If the foreign body is of some size (the point of a foil or a poniard, a metal rod, etc.) the treatment is the same as in the previous case. Do not be influenced by the idea that the foreign body may be acting as a plug in a cardiac perforation, and that its withdrawal may cause the patient's immediate death. Although there have been some remarkable instances of prolonged tolerance of the presence of a foreign body, yet in all probability if it is not removed the patient soon dies.[6]

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[1] Including five cases of bullet wounds.

[2] *Loc. cit.*

[3] The very grave prognosis of needle wounds of the heart (14 deaths in 23 cases, in Loison's statistics) shows very clearly the great responsibility associated with passive measures, even in cases where the immediate symptoms are apparently mild.

[4] The case was one in which a needle had penetrated to the left of the sternum, one inch from the middle line and the same distance above the tip of the xiphisternum, in a child eleven years of age. The skin was slightly elevated over the extremity of the foreign body. René Le Fort was afraid to make an incision directly over it lest he should push it further in: he therefore incised the skin transversely a quarter of an inch below the projection and exposed the head of the needle, which was then extracted with forceps. Recovery. (*Société centrale de médecine du Nord*, 12 oct., 1900.)

[5] This accident happened four times in a series of cases collected by Loison; in one case the patient himself tried to withdraw the needle, which broke in the wound; in six cases the needle was extracted by a surgeon, a preliminary incision being necessary in three; these six patients recovered.

[6] Tillaux has recorded the case of a lunatic, who had thrust an iron rod, six inches long, into the heart region: it could be felt under the skin a little above the wound of entry, and was pushed markedly forward with each cardiac contraction. On the day after the injury, a small incision was made and the rod sought for; it had already passed further in. The moment it was touched with the point of the knife the patient had an attack of syncope and the operation had to be stopped. The foreign body gradually disappeared, and the patient seemed to recover. Later, however, pulmonary symptoms appeared and the patient died. The metal rod had penetrated the middle of the left border of the heart: it was lodged in the thickness of the posterior wall of the left ventricle, from which it emerged near to the posterior interventricular furrow and extended into the lower lobe of the right lung. (Tillaux, "Non-penetrating wound of the heart, wound of both lungs. Sojourn of a metal rod, 6 in. long and ½ in. in diameter, for thirteen months in the thoracic cavity." *Bull. de la Soc. de chir.*, 1868, p. 118).

Moreover, the foreign body buries itself fairly rapidly, and becomes less and less accessible, which is an additional reason for immediate action. But in such a case the extraction should always be performed through an open wound, and the operator must be prepared to deal with any of the possible conditions, to open the pericardium (in the manner already described), and to suture a cardiac wound if necessary.

Lastly, it may happen that the foreign body has altogether disappeared, and then the decision must be based on the cardiac symptoms (signs of pericardial effusion, dyspnœa, feeble, frequent, and irregular pulse, threatened collapse).[1] If operation is undertaken it will be well, at once, to provide free access by cutting an osteoplastic flap (*Fig.* 215, *et seq.*) without waiting to search for the point of entry or trying to follow the wound track.[2]

PERICARDIAL PUNCTURE AND PERICARDIOTOMY.

1. **Pericardial Puncture.**—This may be required as a temporary measure in some cases of traumatic hæmopericardium: it is, however, in pericarditis with effusion, when the quantity of fluid and the pressure which it exercises are seriously interfering with the action of the heart, that it finds its special indication. The reasons for intervention must be drawn from the physical signs and the cardio-pulmonary functional disturbances; in such circumstances, the uncertainty associated with a waiting policy, and the danger of sudden death, emphasize the need for prompt decision and action.

Later, when speaking of left-sided pleural effusion associated with displacement of the heart, we shall have to insist on the necessity for early evacuation of the fluid. The situation is equally urgent when the heart is directly immersed in an abundant accumulation of fluid, contained, under pressure, in its fibrous sheath. Yet, though thoracocentesis is the common practice in the one case, it is far from being so—due consideration being given to the difference in frequency of pleural and pericardial effusions—with regard to **paracentesis of the pericardium.** The difference in practice is due undoubtedly to the instinctive fear of wounding the heart.

There are three structures which may be injured in making the puncture, the *internal mammary artery*, the *costo-mediastinal pleural cul-de-sac*, and *the heart*. The artery can be easily avoided if its position, one finger's breadth from the sternal border, is kept in mind: a careful preliminary examination, and the introduction of the needle or trocar in the direction and with the precautions to be subsequently given, will obviate the risk of any laceration of the myocardium. The pleural cul-de-sac is much more vulnerable, being usually prolonged under the margin of the sternum. Undoubtedly, in some cases this pleural diverticulum is obliterated by adhesions between the two layers;[1] undoubtedly, also, the escape of a few drops of fluid from the cannula is often unattended by any pleural reaction.

[1] Radiography would be indispensable.

[2] If there are no symptoms, naturally no exploration will be made: this remark applies equally to cases of bullets in the heart, lodged in the myocardium or even in the cavities.

as has been proved in many cases; still it is impossible to be sure beforehand of the nature and degree of septicity of the pericardial fluid, and if it should be purulent or definitely infectious, possible inoculation of the pleura is a serious risk, which must be neutralized as far as possible by **the choice of the site of puncture.**

The puncture may be made **in the 5th left intercostal space close to the sternal border** (Baizeau and Delorme's method), or **at four fingers' breadth from the sternum** (Dieulafoy's method). A puncture made after the latter method must of necessity traverse the pleural cavity (*Fig.* 220).

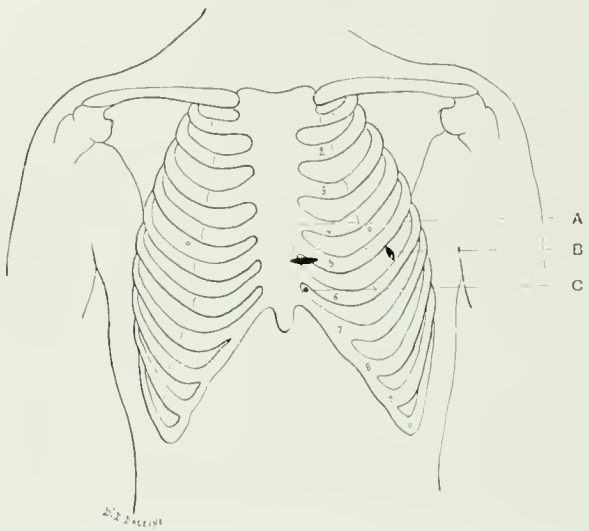

Fig. 220.—Positions for puncturing the pericardium. (A) Parasternal puncture (small preliminary skin incision). (B) Lateral puncture (small preliminary skin incision). (C) Puncture at the inner extremity of the sixth space (Voinitch-Sianojensky).

Practically, when about to evacuate a pericardial effusion, it will be well to proceed as follows: First make an exploratory puncture, using an ordinary hypodermic syringe and a long fine needle; introduce the needle in the *5th left intercostal space close to the sternal border*, directing it obliquely *downwards and inwards*. If the fluid obtained is simply serous or hæmatic, the evacuating puncture can be made at the "medical" point of election, 2 or $2\frac{1}{2}$ inches from the sternum; but if the fluid is purulent or sanious, blackish, and containing gas, any subsequent puncture must be made by Baizeau and Delorme's method. The puncture may be made to relieve immediate symptoms of compression, but under these circumstances be prepared to follow it up with the least possible delay by pericardiotomy.

[1] If there is a copious pleural effusion, it will be well to perform thoracocentesis first of all.

The puncture, wherever its site may be, should be made with a needle or fine trocar and cannula[1] fitted to an aspirating apparatus. It is well to make a small preliminary incision in the skin with a scalpel at the site of the puncture; by this means the necessity for considerable pressure in perforating the resistant skin will be avoided, and consequently the risk of the point penetrating too deeply.

(*a*). **Lateral Puncture.**—In making the lateral puncture, four finger-breadths from the sternum (*Fig.* 221), incise the skin vertically over the intercostal space for half an inch: then, placing the trocar in the little wound, push it gently through the intercostal plane and direct it *obliquely inwards almost parallel to the deep surface of the thoracic wall.* The tense surface

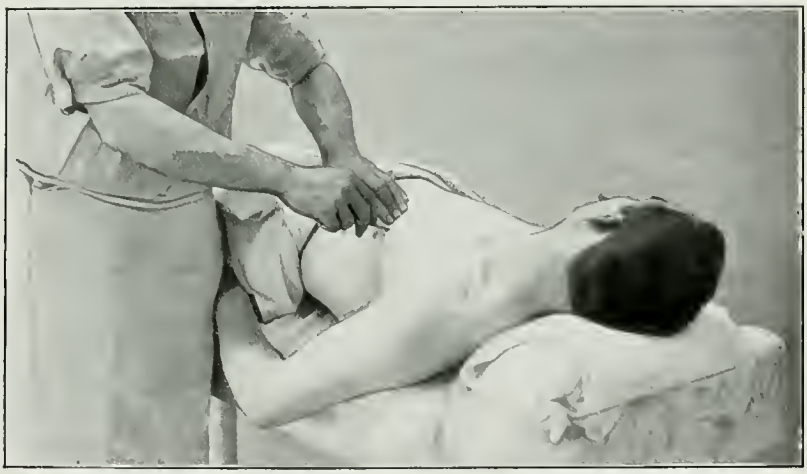

Fig. 221.—Lateral puncture of the pericardium.

of the pericardium can usually be felt quite plainly, and a definite sensation of resistance can be perceived when perforating the wall of the sac.[2]

The pericardial wall is always fairly dense and is sometimes very thick, and when distended with fluid it requires a very definite effort to make the trocar perforate it. There is a certain knack in making the final puncture: it requires a little sharp thrust with a firm hand, while keeping the instrument well under control, so as to prevent it from passing too deeply when the resistance is overcome.

[1] Corresponding to Dieulafoy's No. 2 needle; the needle has the advantage of allowing one to approach the fluid with the vacuum in action (the bottle having been aspirated and the tap being open), and consequently, as the channel is open, the flow at once indicates that the level of the fluid has been reached; on the other hand, the needle is easily obstructed in passing through the tissues, and further, its use is attended with a greater risk of puncturing or lacerating the heart.

[2] It is never advisable to make the needle penetrate further than an inch from the surface; if you find nothing at that depth it will be better to give up the puncture and do a pericardiotomy. (See Terrier et Reymond, *loc. cit.*, p. 122.)

The trocar is withdrawn in the ordinary manner, and the fluid allowed to escape rather slowly from the cannula, the point of which is kept steady, raised, lowered, or pushed farther in as the flow of the fluid demands.[1]

Very quickly, before the evacuation is nearly completed, the heart begins to beat against the cannula; it does no harm, however, as the organ simply rubs against the rounded end of the instrument; but if the needle is being used very great care is required: the instrument must be held in such a manner that the point is directed downwards and inwards along the inner surface of the pericardial wall. After the cavity has been emptied as far as possible, the needle or trocar is withdrawn by a sharp movement to avoid the escape of any drops of liquid into the pleura.

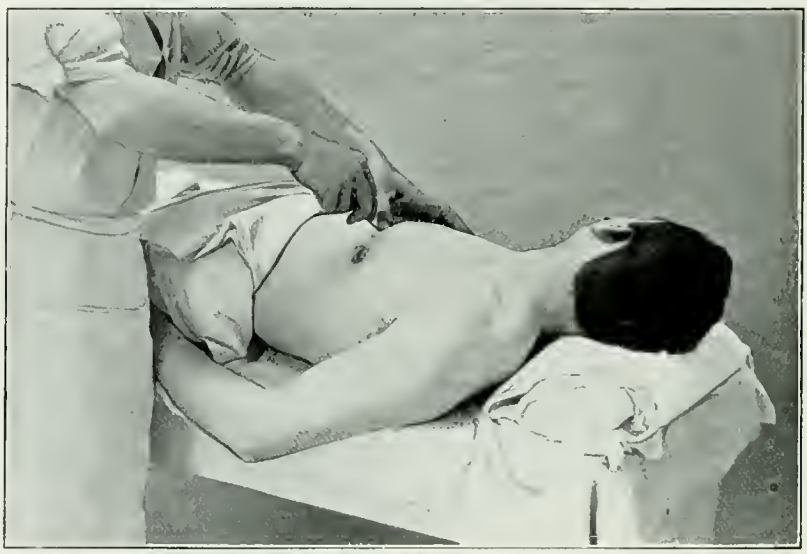

Fig. 222.—Parasternal puncture of the pericardium.

(*b*). **Parasternal Puncture.**—Here, the technique is somewhat more difficult. A small transverse skin incision is made at the inner extremity of the 5th left intercostal space.[2] This incision should be about $\frac{3}{4}$ in. long and extend a little way on to the border of the sternum, which should be clearly exposed; on this border, and in contact with it, the trocar is passed through the wall (*Fig. 222*), it is then *inclined inwards behind the sternum*, and after having been carried half or three-quarters of an inch in that direction, the handle is raised a little and the point of the instrument made

[1] When the flow lessens, or if at first it is very scanty, do not forget to have the patient raised into a sitting position.

[2] Voinitch Sianojensky advises that the puncture should be made at the inner extremity of the sixth space, close to the sternal border, the pleural cul-de-sac being almost constantly absent at this level. ("La péricardiotomie et ses bases anatomiques." *Revue de chir.*, 1898, p. 993.)

to penetrate in *an inward and downward* direction into the tense anterior wall of the pericardium, which can be felt behind it.

In this way, instead of making a direct puncture at the border of the sternum, work round the margin of the pleural cul-de-sac in order to perforate the pericardium behind the sternum at the point where it is uncovered by pleura and directly accessible: a rather delicate little operation, but still one which can be fairly easily performed.

Here again, if the puncture yields pus, it will be, *ipso facto*, inadequate, and sometimes dangerous, and one must have recourse to the operation for empyema of the sac: I mean free opening and drainage of the pericardium.

2. **Pericardiotomy.**—Incision of the pericardium becomes urgently necessary in cases of hæmopericardium, in the cases of infected hæmopneumopericardium, and in all the varieties of suppurative pericarditis. Like empyema of the pleura, a pyopericardium ought to be opened and drained at the earliest possible moment, the indications being equally urgent in either condition.

Under these circumstances there is no need for a large preliminary thoracotomy and raising an osteoplastic flap; but in order to open the pericardium satisfactorily, in a dependent position and without wounding the pleura, it is necessary to secure sufficient room. An attempt to open the cavity by an incision in an intercostal space—the 4th or 5th for instance—would be, notwithstanding its apparent simplicity, a difficult and dangerous operation. Excision of one or more costal cartilages is therefore essential, and it can be done by either of the following methods :—

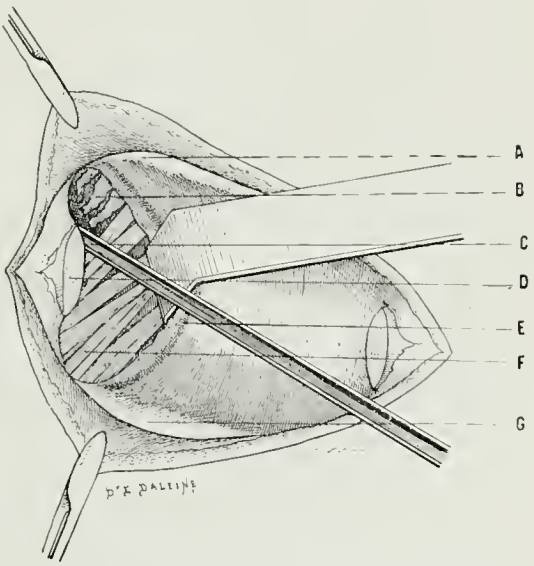

Fig. 223.—Pericardiotomy; excision of the fifth costal cartilage; the triangularis sterni is detached and drawn outwards with the pleural cul-de-sac and the internal mammary artery. (A) Fourth costal cartilage. (B) Upper digitations of the triangularis detached with the director. (C) Director, working under the left border of the sternum, parallel to its posterior surface. (D) Internal extremity of the fifth cartilage, resected. (E) Internal mammary artery, retracted with the intercostal layer of tissue. (F) Lower digitations of the triangularis. (G) Sixth costal cartilage.

(*a*). **Excision of the 5th Costal Cartilage** (Ollier).—Make an incision about three inches long, beginning at the mid line of the sternum and running outwards over the 5th cartilage. Expose the cartilage at once and divide it close to the sternum with the knife; then slip the end of the elevator underneath and clear its deep surface, raise it, and turn it outwards. It

dislocates readily at the costo-chondral articulation, and the extirpation can then be quickly completed. The lips of the cutaneous incision being now retracted upwards and downwards, the 4th and 5th spaces are before you. Incise the intercostal layer parallel and close to the sternum, and draw it outwards; you are now on the second layer, the triangularis sterni.

Now remember a fact pointed out by MM. Delorme and Mignon: *the pleural cul-de-sac adheres only slightly to the pericardium, but very firmly to the triangularis sterni.* Therefore the triangularis must be detached and pushed outwards; in doing so the pleura will be displaced at the same time, and the anterior wall of the pericardium laid bare.

The triangularis sterni is attached to the posterior surface of the sternum by a series of flattened digitations which blend with the superficial layers of the periosteum. Therefore introduce the director *under the sternal border parallel to the deep aspect of the bone*, and work it upwards and downwards in order to separate these tendinous attachments (*Fig.* 223).

The next step of the process is best carried out by means of the finger: through the opening made with the director the index finger is carried behind the sternum, and then retracts all the pre-pericardial tissues from within outwards. The pleural cul-de-sac and the various layers of parietal tissues which have been traversed are placed under a retractor; between this retractor and the border of the sternum the pericardium is now directly exposed.

The internal mammary artery is situated between the intercostals and the triangularis; it now lies under the retractor, and has not been seen because the intercostal plane was opened close to the border of the sternum. If it should be necessary to expose a larger pericardial surface, the intercostal layer could be divided above and below, the internal mammary cut between two ligatures, and the pleural cul-de-sac with the overlying tissues pushed further outwards.

(*b*). **Excision of the 5th and 6th Cartilages** (Delorme and Mignon).—An **I**-shaped incision is made; the vertical limb lies at a finger's breadth from the border of the sternum and descends from the upper border of the 4th rib to the lower border of the 7th; the horizontal cuts extend inwards for about half an inch over the front of the sternum and outwards for an inch, or more if necessary.

The knife is carried right down to the cartilages, and the two cutaneous flaps, together with the inner fibres of the pectoralis major, are rapidly raised and turned inwards and outwards. The 5th cartilage is then divided close to the sternum, and raised; its borders and deep surface are cleared, and it is then detached by dislocating it outwards. The 6th cartilage is treated in the same manner.

The intercostal tissues of three spaces are now exposed, separated by intervening bands of perichondrium. Make a vertical incision in this first tissue plane, close to the sternum; the director slipped behind the sternum and working from below upwards, close to the posterior surface of the bone, separates the attachments of the triangularis, which is then retracted outwards by the finger, along with the overlying internal mammary artery and the underlying pleural cul-de-sac.

The pericardium is now to be opened *below and to the left*; however great the distention of the pericardium may be (and often it is enormous), the opening must always be made with the greatest caution.

Seize the newly exposed anterior wall with two pairs of Kocher's forceps, lift it, and incise carefully between the forceps; the great thickness of the fibrous wall which has to be cut through is sometimes quite astonishing. When the distention is great, the forceps may slip and refuse to bite on the convex wall; in such a case, make a very small incision, and grasp and raise the edges before enlarging the opening. The fluid accumulates particularly in the retrocardiac portion of the pericardial sac, and, even where the effusion is very large, the heart is often pushed forward into a position where the knife, if incautiously handled, would be likely to wound it.

When pericardiotomy is performed for an *infected hæmopericardium* or in a case of *suppurative pericarditis*, free irrigation with tepid sterile saline solution is often useful in removing the clots or the shreds of fibrinous lymph; it will be followed by drainage with one or two tubes fixed in a dependent position in the lower angle of the wound.[1]

PLEURAL PUNCTURE AND PLEUROTOMY.

Thoracocentesis is a harmless procedure, so long as it is performed aseptically. That is, the trocar and cannula must be boiled, the area where the puncture is to be made thoroughly washed with soap and water, bathed with spirit and sterile saline solution, the operator's hands carefully prepared, soaped, brushed, and bathed with spirit and boiled water, and the simple precaution observed of protecting the sterilized trocar from any septic contact.

Pleural Puncture.—Generally speaking this should be made in the 7th or 8th intercostal space, in the mid-axillary line;[2] this point of election, though convenient in large effusions, is not, however, always applicable, and must naturally be changed in some localized pleural accumulations.

Puncture at the centre of the dull area: this is the general rule, and in order to carry it out the dullness should be mapped out afresh at the last moment, just before making the puncture.

The patient lies on the sound side, the shoulders well raised and supported by pillows, the arm on the affected side drawn forwards and upwards (*Fig. 224*). The aseptic preparation having been made in the manner already detailed, mark the upper border of the rib at the chosen spot with the tips of two fingers of the left hand, apply the point of the needle or trocar just above the costal border, and introduce it with a single sharp thrust.

[1] The patient should be kept as far as possible in the sitting position, which greatly facilitates the emptying of the pericardium.

[2] To avoid the diaphragm, it is prudent not to make the puncture at less than three inches above the costal margin.

A considerable effort is often necessary to perforate the skin; undue roughness is to be avoided, but the puncture may be made fearlessly. Remember that when the pleura is thickened and the walls are infiltrated, the point of the instrument must sometimes be introduced to a depth of an inch or an inch and a half before fluid is reached. Once the wall and the membrane have been pierced, the sensation of lack of resistance and of being in a free cavity will be quite plainly perceived.

The puncture should be made with an aspirating apparatus, which forms a part of the necessary primary equipment. But should it happen in an emergency that only an ordinary trocar and cannula are at hand,

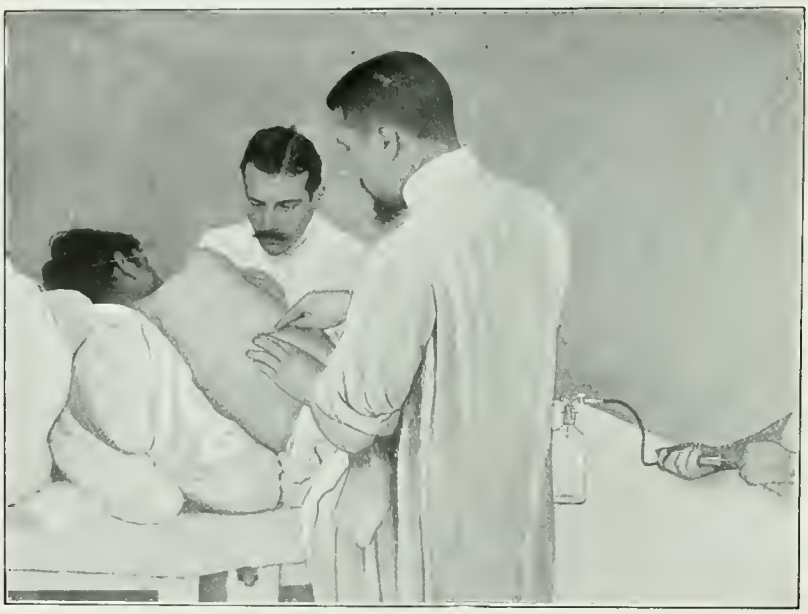

Fig. 224. Pleural puncture.

that instrument will answer perfectly well if care be taken to surround the outer end of the cannula with a cover of sterilized linen or muslin. This is an old method of Reybard's.

When the effusion is purulent, simple puncture is inadequate; and this is a general statement which applies to all cases of suppuration within serous cavities.

We are well aware that some *pneumococcal suppurations*, in the pleural as well as in the peritoneal cavity, are particularly benign, and that some cases of pneumococcal empyema may be cured by one or more aspirations. Still, simple evacuation of the pleural contents by the trocar will only be advisable in cases where a careful bacteriological examination of some of the pus, obtained by a preliminary puncture with an exploring syringe, has

shown conclusively that it is of purely pneumococcic origin, and, we may also add, when the mildness of the general and local symptoms are in keeping with the bacteriological findings.

Practically one can never be sure of the exact nature of any case of purulent pleural effusion, and the invariable rule of good surgery is: when pus is found, open freely and drain; in other words, do the operation for empyema.

It seems to us that the discovery of pus by puncture constitutes in itself an urgent indication for the operation. There are certain conditions, however, which create still greater urgency: *the abundance of the effusion*, indicated by dullness extending up to the spine of the scapula, the complete absence of vocal fremitus or respiratory murmur in the same area, and the bulging of the side of the chest; sometimes *the situation of the effusion* in the *left pleura* and displacement of the heart; signs of *serious infection*: high temperature—continuous or oscillating widely—rapid and feeble pulse, shivers, earthy colour of the skin, general malaise and depression; in certain cases, which ought to be very exceptional, an œdematous and fluctuating swelling in the thoracic wall, indicating *a subcutaneous extension of the suppuration* (empyema necessitatis); or, again, *a bronchial fistula*.

On the other hand, one might say it is never too late to operate: no matter how serious the patient's condition may apparently be, one should never refuse him the benefit of an operation which in itself presents no real gravity. I have operated on and cured patients who appeared to be practically dying, whom an empyema, long unrecognized or treated for a long time by aspiration, had reduced to such a condition that it seemed as if the slightest shock would be fatal. These chronic, putrid pleural suppurations may produce all the appearances of far advanced pulmonary tuberculosis: do not hesitate, however, to open the pleura freely; there may still be time, if the vital forces are equal to the task of carrying out the reparative processes. Sometimes results will be obtained far beyond one's utmost hopes, and one does not know and cannot say in advance that the vital powers are insufficient and that the case is hopeless. In my opinion even undoubted and extensive pulmonary tuberculosis should not be considered, in itself, as a contraindication to operation.

I think it is impossible to insist too strongly on the need for pleurotomy in these cases, at the earliest possible date. Further, the operation is one which every practitioner should be able to do properly and should be willing to undertake.

Let us first assume that we have to deal with an *ordinary purulent pleurisy with a large effusion*; afterwards we shall see how the technique must be modified in some of the more uncommon forms.

I.—ORDINARY PURULENT PLEURISY WITH A LARGE EFFUSION.

A trocar and cannula, a scalpel, dissecting forceps, some pairs of pressure-forceps, and two large-sized drainage tubes will be required; it will also be well to have an irrigator, and a gallon or so of boiled water.

The instruments, the irrigator, and the drainage tubing will be sterilized in the manner already described. A general anæsthetic is preferable, unless dyspnœa is too great: it must be very carefully administered, and in the smallest possible doses. If the respiratory difficulty appears to be too serious, then local anæsthesia with ethyl chloride or cocaine will suffice. In conditions of extreme urgency one will dispense with any anæsthetic, and can then work more quickly, under such circumstances a point of very great importance.

The patient lies on his back, but inclined to the sound side, with the head and the upper part of the chest raised by cushions or pillows, and the whole of the side of the chest well exposed (*see Plate V.*).

Before cleansing the hands and the skin of the operation area, map out the dullness afresh and fix the position of incision. Remember that generally pleurotomy is performed in the 7th intercostal space on the right side and in the 8th space on the left side, just behind the mid-axillary line (the vertical line which ends above at the apex of the axilla);[1] but one must not adhere too closely to these rules, which have only a general application: make your incision at the inferior and posterior part of the dull area, at the point where pus has been found by the exploring needle.[2]

If at the last moment there is any doubt whatever, then confirm the previous examination by making a puncture with a fine exploring needle in the space chosen: should the pus run, one is doubly sure of being in good position, and the rest of the operation ought to be no more difficult than the opening of an abscess. If preferred the needle may be left in place to act as a guide, but this is rather an unnecessary complication.

The pus is there, behind a wall formed by the skin, the intercostal muscles, and the parietal layer of the pleura; the wall is often greatly thickened by œdema, but its incision does not thereby become any more dangerous: the lung is pushed far out of the way, much farther for instance than the intestine in a case of iliac abscess; the intercostal artery is protected by the lower edge of the rib above.

Of course the whole region will have been properly prepared and surrounded by sterile towels (*Fig.* 225).

Simple Intercostal Incision.—Feel for the rib which bounds the chosen space below, and mark its upper border with the fingers of the left

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[1] Walther has shown that an incision three inches in length placed posteriorly over the upper border of the 9th rib opens the pleural cavity at its most dependent point, and therefore at the point most favourable for complete emptying and drainage. In the child, an incision one inch in length along the upper border of the 10th rib, and commencing one inch from the spinous processes with an infant under three months of age, two inches in an older child (up to thirteen years), presents the same advantages and insures satisfactory drainage of the pleural cavity without any ultimate deformity of the thorax. (J. B. Baudon. *De la thoracotomie postérieure dans le traitement des pleurésies purulentes de l'enfance.* Thèse. 1897, No. 433).

[2] It is always well to go as near as possible to the postero-inferior part of the thorax, without ever descending below the 9th intercostal space, and to remember that there is danger of wounding the diaphragm at that level if the operation is not very carefully performed: nor again is it ever advisable to invade the mass of the erector spinæ muscles, which bleed badly when cut, and give but little room for the deeper steps of the operation.

Plate V.—Operation for empyema. Position of the patient. Incision of the intercostal muscles along the upper border of the rib.

OPERATION FOR EMPYEMA

hand (*Fig.* 225): make a cutaneous incision three inches in length over that border; with a second cut divide the intercostal plane evenly and without any hesitation (*Plate V.*): if the pleura is opened with this cut it is of little consequence; but it is usually preferable at this step to divide the intercostal muscles only. Do not expect to see the pleura projecting in the bottom of the wound as a definite smooth tense membrane: usually one will come down upon a yellowish, œdematous layer of tissue; carefully puncture this with the point of the scalpel at the centre of the incision, *keeping close to the upper border of the rib below:* very soon the pus will begin to escape along the knife-blade. Enlarge the incision sufficiently to allow the introduction of the index finger, with which the opening may be extended to the limits of the cutaneous wound. The finger is usually quite

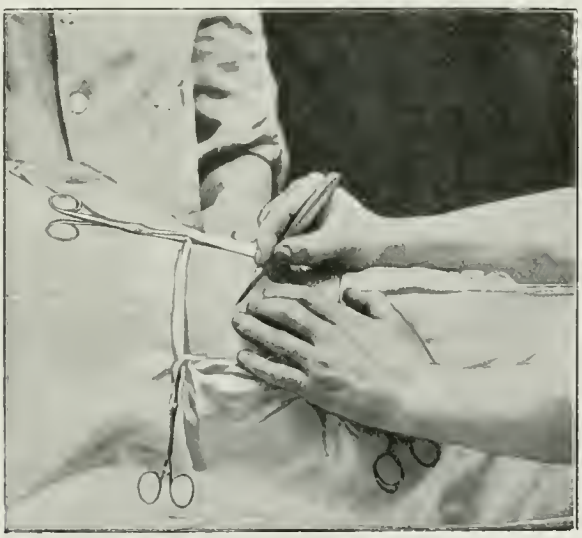


Fig. 225.—Operation for empyema by simple intercostal incision. The operator marks the upper border of the rib with the fingers of the left hand, and makes the incision along that border.

sufficient for this enlargement; but if the use of the knife or scissors is necessary, the instrument must be preceded by the finger placed under the membrane as a guard, particularly in left-sided pleurisies, and when the operation is performed very low down or in front.

The pus is now escaping freely. Have the patient gently raised into a sitting position and at the same time turned towards the side where the chest has just been opened; the coughing, which may be artificially provoked if necessary, will aid greatly in emptying the pleural cavity.

Remember that very thorough emptying of the cavity is required, and is an essential feature of pleurotomy without irrigation. The fluid is often

mixed with large masses of purulent fibrinous lymph,[1] which occupy the inferior pleural cul-de-sac, lodge in the angles of the cavity, or adhere loosely to the surface of the lung: coughing brings them into the wound, whence they can be removed with the fingers.

As a rule *irrigation should not be employed*, particularly if the fluid is thin, yellow, and odourless, and if the lung expands as soon as the pleura is emptied. If the pus is reddish in colour and foul-smelling, or if there are symptoms indicative of serious septic absorption, immediate irrigation with warm boiled saline solution is sometimes good practice. When the cavity is divided into pockets by imperfect partitions and filled with grumous masses of lymph and false membrane, the evacuation should be completed with the aid of swabs mounted in forceps and handled very gently.

Good drainage finishes the operation. Drain with two large thick-walled tubes, sufficiently rigid to resist the pressure of the edges of the wound in some degree, and long enough to reach to the bottom of the pleural cul-de-sac: introduce them with forceps and guide them with the finger to make sure that they are properly placed: a sterilized safety-pin passes through both, and serves to prevent them from slipping in. If the incision is very long, one or two sutures may be introduced at the angles (*Fig.* 226).

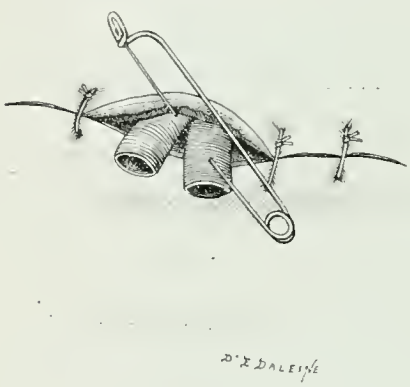


Fig. 226.—Drainage after an operation for empyema.

The dressing is an important factor in the subsequent progress of the case. Several crumpled folds of sterilized gauze are placed on the wound between its edges, around and over the drainage tubes:[2] over the gauze a thick layer of wool (also sterilized), and outside that again a layer of ordinary wool enveloping the entire chest, and secured with a broad flannel binder. The binder must be carefully and firmly applied, and kept from slipping down by two flannel straps passing over the shoulders and pinned to it in front and behind.

The patient is placed in bed in the semi-sitting position, a little inclined to the operated side: a small pillow slipped under the other side of the chest will enable the position to be maintained without fatigue. Do not forget that a dressing, through the outer layers of which discharges from the wound have soaked, becomes a possible source of serious sepsis: there-

[1] Particularly in pneumococcal empyemas.

[2] This gauze is used merely as a wound covering, and to steady the drainage tubes: it should never be used as a "packing"; further, the cavity must always be drained with a tube: a gauze mesh is worse than useless, for it merely acts as a plug in the opening, preventing the escape of the secretions.

fore it will often be necessary during the first two or three days to change the binder and the outer layer of wool, perhaps even the whole dressing, without, however, disturbing the drainage tubes. *No irrigation should be employed*, even if the temperature remains about 101° for the first few days; it is only when the temperature is unduly high and accompanied by symptoms of septic absorption, or when it is prolonged beyond the time mentioned, that the cavity should be irrigated.

Warm boiled water, or, better, salt solution, should be used; with an irrigator and a glass nozzle properly sterilized, several quarts can be passed through the suppurating cavity, which is gently filled without exercising any pressure; then the patient is made to cough, which forcibly expels the fluid, bringing with it the pus which has been stagnating in the dependent parts, fragments of membrane, etc.; the process is repeated again and again until the washings are returned clean.

The use of antiseptic solutions is illusory or dangerous: the well-grounded fear of poisoning compels the use of exceedingly weak solutions: under such conditions what beneficial action can be expected during the course of an irrigation which lasts at most for a few minutes? Here, as in many other circumstances, irrigation can only be a means of cleansing and mechanical disinfection, and normal salt solution is therefore the fluid of choice.

Such is the technique of pleurotomy in the great majority of cases of empyema: it is a definite, simple, and safe operation, but it demands, if its full benefits are to be obtained, the exercise of rigorous asepsis in its execution, in the dressing, and in the after-treatment.

It is a serious and dangerous mistake to think that the presence of pus does away with the need for ordinary aseptic precautions. We know too much regarding combined infections, not to be aware that in opening a collection of pus with dirty hands or a dirty knife, and through dirty skin, there is a risk of producing a secondary local infection, and that the natural processes of cure are always retarded, altered, or complicated.

This applies as much to the after-dressings as to the operation itself. Several times after a satisfactory pleurotomy which had been followed by a fall of temperature and considerable general improvement, I have seen a recrudescence of symptoms, and the development of serious pulmonary complications, owing to a careless dressing.

This method of simple intercostal incision is quite satisfactory in many recent cases of empyema; but it is not adequate in the graver forms, where a large parietal opening is required for the complete evacuation of the pleural contents and proper drainage of the septic focus. These desiderata can only be obtained by costal resection, and indeed excision of a segment of a rib adds so little to the operation, and is so useful, that in my opinion it is always to be preferred, at least in the adult.[1]

[1] In England costal resection is regarded as the routine operation for empyema. (Translator's Note.)

Costal Resection.—This requires only two instruments additional to those before mentioned : a periosteal elevator and a pair of bone forceps or a costotome.

Make an incision three or four inches long, with its centre in the mid-

Fig. 227.—Costotome.

axillary line over, say, the 8th rib : go right down to the bone at once, and incise the periosteum longitudinally on its outer surface (*Fig.* 229).

Strip up the periosteum with the elevator, first above, then below ; work the elevator carefully round the lower border of the rib to clear the membrane from the subcostal groove, and with it the intercostal vessels (*Fig.* 230) ; then carry the instrument backwards and forwards along the deep surface of the bone ; the periosteum separates easily, and with it the underlying pleura is pushed out of the way. Then take the special rib-cutting forceps, the costotome (*Fig.* 227) if one is at hand, or if not, the ordinary bone forceps (*Fig.* 228) : slip one of the jaws between the inner surface of the rib and the periosteum, and cut the bone at the extremity of the bared segment with a sharp movement ; without disengaging the forceps, slide the jaws along to the other extremity and cut again. If the pleura has been well separated the manœuvre is quite simple ; if not, after making the first bone section, seize with lion forceps the cut end of the segment to be removed, raise it up, complete the clearing of its deep surface, and then make the second section (*Fig.* 231).

Fig. 228.—Liston's bone forceps, slightly elbowed on the flat.

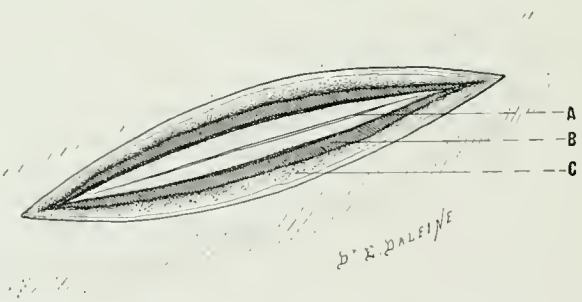


Fig. 229.—Operation for empyema with costal resection. 1st step. The initial incision goes right down to the bone. (A) Incision of the costal periosteum. (B) Incised peri-thoracic muscles. (C) Subcutaneous fatty tissue.

The excised portion of rib should be always two inches long at least, longer still when the area of intrapleural suppuration is very extensive; great care should be taken to make the bone sections at the extreme limits of the segment which has been stripped of periosteum and in line with the angles of the skin incision: otherwise a stump of rib, stripped of periosteum, will be left exposed at either extremity, and may easily necrose.

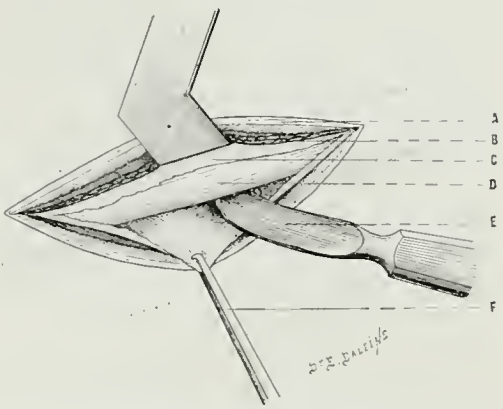
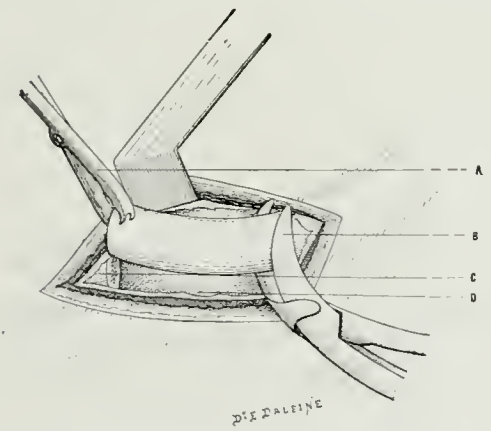


Fig. 230.—Operation for empyema with costal resection. 2nd step: Stripping up the periosteum. Clearing the lower border of the rib. (A) Cutaneous incision. (B) Muscular layer. (C) Upper edge of the costal periosteum. (D) Bared portion of the rib. (E) Elevator, freeing the lower border of the rib and clearing the subcostal groove. (F) Lower edge of the periosteum held and stretched by forceps.

The next step is to incise the "bed" of the segment of rib which you have just removed: in other words, the subcostal periosteum and pleura, which at this level are the sole remaining constituents of the wall (*Fig.* 232). Taking the same precautions as before, puncture first with the point of the knife, and when the pus begins to escape, introduce the finger, and, on it as a guide, extend the opening out to the limits of the cutaneous wound.



[*Fig.* 231.—Operation for empyema with costal resection. 3rd step: Resection of the rib. (A) Bone forceps pulling up the cut end. (B) Costotome. (C) Anterior portion of the rib. (D) Subcostal plane.

There is now a long slit-like opening into the pleural cavity, bounded above and below by an intercostal space. If the wall is thickened by œdema, the inferior or both lips of the pleural incision may be incised vertically, the two ends of the cut intercostal artery being tied. In this fashion a free drainage track is provided in the best possible manner, and with good drainage,[1] rapid drying up of the pleura, and healing without the formation of a fistula, are to a great extent assured.

[1] Free and dependent.

In our opinion, therefore, this method of pleurotomy *under a resected rib* is the method of choice, and personally we always employ it except in recent and benign cases.[1] The preliminary costal resection cannot be considered as a complication: by proceeding in the manner we have described, cutting down boldly on to the rib, the operation is simple and can be rapidly performed. Nor have we ever seen any trouble or delay in the healing of the thoracic wall.

A few words only with regard to "*empyema necessitatis*" and *double empyema*.

Empyema necessitatis should no longer be seen; yet it is less uncommon than one could wish, both in the child and the adult.

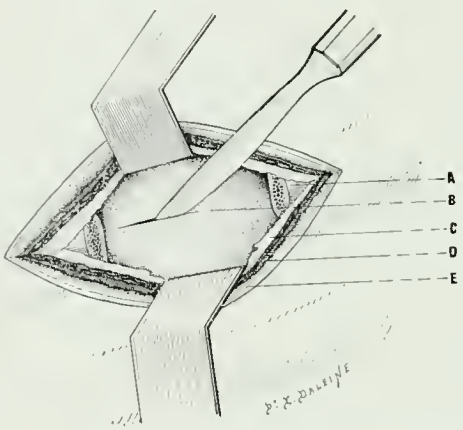


Fig. 232.—Operation for empyema with costal resection. 4th step: Incision of the pleura. (A) Anterior portion of the resected rib. (B) Parietal pleura covered by the subcostal periosteum. (C) Outer layer of periosteum, stripped up and retracted. (D) Muscular plane. (E) Cutaneous incision.

During the course of a purulent pleurisy wrongly diagnosed or treated by repeated punctures, a swelling may appear over an intercostal space, most frequently in front in the mammary region; the swelling enlarges, reddens, and points: this is a subcutaneous abscess, a prolongation of the intrapleural accumulation which has made a track for itself through the thoracic wall.

The abscess must be opened; but that alone is not usually sufficient, because it is situated high up, well above the lower limits of the pleural sac.[2] and drainage is consequently very unsatisfactory. The operation must therefore be completed by opening the pleura, *below and behind*, after the resection of a segment of rib. Indeed it would be better, after making sure of the presence of pus in the pleural cavity, to begin by performing the low pleurotomy, as the operation could then be done on a wall not yet contaminated by the purulent discharges.

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[1] In the child it is advisable to be very careful in interfering with the thoracic skeleton; small excisions usually suffice, if indeed they are necessary at all, the purulent pleurisies of childhood being most frequently of pneumococcal origin (Netter) and comparatively benign and curable. "Owing to the elasticity of the thorax at this age, the wall falls in very readily, and large resections may involve very grave immediate disadvantages or subsequently secondary spinal deformities in the shape of irremediable and very marked curvatures." (Ollier).

[2] I have opened an *empyema necessitatis* in the lumbar region which had been taken for a perinephritic abscess; at the bottom of an enormous subcutaneous cavity, an opening large enough to admit two fingers communicated through one of the lower intercostal spaces with the pleural cavity: the opening was enlarged transversely, excellent pleural drainage being thus provided. Recovery.

In **Double Empyema,**[1] which is most frequently of pneumococcal origin,[2] *both pleural cavities may be opened at the same time* if the symptoms are very urgent.

The adhesions which exist in these cases prevent the sudden and complete collapse of both lungs, which formerly made surgeons dread the bilateral opening of the thorax, and numerous successful cases have demonstrated that incision pure and simple of collections of pus in both pleuræ at the same sitting is good practice. It will often be advisable, however, to perform pleurotomy, with or without costal resection on the side where the effusion is most abundant, and to puncture on the other side, which can in its turn be incised some days later.[3]

II.—OTHER FORMS OF EMPYEMA.—MEDIASTINAL ABSCESS.

Apart from the ordinary type of purulent pleurisy, difficulties may occasionally be encountered owing to the special situation of the pus; I wish to speak particularly of the *multilocular* (*Fig.* 233), the *supra-diaphragmatic* (*Fig.* 234), and the *interlobar* forms (*Fig.* 235).

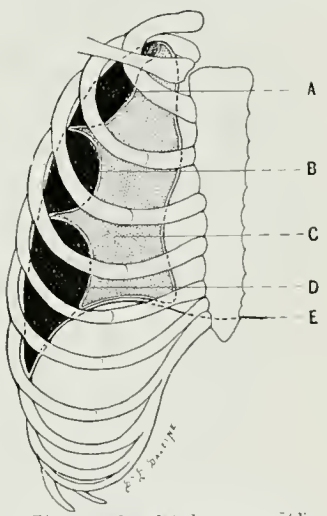

Fig. 233.—Loculated empyema (diagrammatic). (A), (B), (D) Pockets of pus. (C) Lung. (E) Diaphragm.

Loculated Empyema.—The following is an example:—A large empyema of the right base, with most characteristic signs, well-marked dullness, absence of vocal fremitus and respiratory murmur: verified by exploratory puncture, pus having been obtained. Pleurotomy was performed in the 7th space, behind the axillary line, within the area of dullness; the skin and the muscles were incised, the pleura was punctured, and the opening enlarged with the finger; only a few drops of pus escaped, and the lung was found covered with a thick yellowish membrane, lying quite close to the chest wall; I had opened a small cavity closed on all sides, and could feel quite plainly the adhesions which bounded it above and below, in front and behind: they were soft and friable, and easily broken down by gentle pressure; soon the appearance of a stream of pus indicated that another and much larger pocket had been opened: I continued the process of separation and finally succeeded in throwing all the pockets into one.

[1] Occurs most frequently in children.

[2] In 28 cases collected by Fr. Weinges (*Chirurgische Behandlung des doppelseitigen Empyems*, Inaug. Dissertation, Fribourg-en-Br., 1901), 20 had followed pneumonia, 1 influenza, and 7 had been preceded by no recognized affection.

[3] After an operation for empyema in the general pleural cavity (an empyema which is not broken up into several pockets by adhesions) the lung quickly recovers its expansibility and respiratory function.

Similar action is indicated when the pleural effusion, instead of occupying the inferior cul-de-sac and thence extending upwards, remains circumscribed near the mid-height of the chest and does not descend to the diaphragm: in such a case the condition has undoubtedly been either an interlobar pleurisy which has gradually approached the pulmonary surface, preceded by the formation of adhesions which have prevented any extension to the general pleural cavity, or the suppuration may have occurred in an area shut off from the rest of the pleural cavity by old-standing adhesions.

In these forms of *localized pleural abscess*, it may be that the incision has been made too low, and does not give access to the focus, but enters the midst of the limiting adhesions. Here again the abscess must be carefully sought by separating the adhesions in the direction of the area where its presence had been demonstrated by the physical signs and the preliminary puncture.

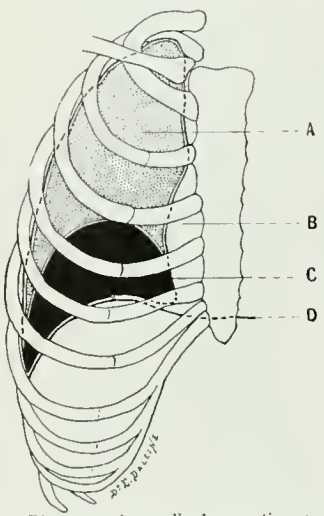

Fig. 234.—Supra-diaphragmatic empyema (diagrammatic). (A) Lung. (B) Mediastinum. (C) Supraphrenic intrapleural abscess. (D) Diaphragm.

Supra-diaphragmatic Empyema.—It is often difficult to determine the exact situation, or even to recognize these supraphrenic intrapleural abscesses in which the pus is contained between the diaphragm and the base of the lung. They are often confounded with subphrenic abscess, the causation, the course, and the line of incision for which are quite different.

When there is reason for suspecting the existence of a purulent pleurisy of this type, the pleurotomy should be practised behind and very low down, in the 8th space on the right side, or the 9th on the left; the pleura must be opened very carefully, because the diaphragm lies close, often adherent to the wall, and very easily wounded; the incision in the intercostal space should be at least four inches long, and it is always preferable to follow the method already described and to resect a segment of rib. Through the large opening thus made, the base of the lung is gently separated, *following the diaphragm* from without inwards, when usually it will not be long before the abscess is found.

These encysted supraphrenic abscesses often lead to the formation of pulmonary cavities and bronchial fistulæ, one reason amongst others being that the correct diagnosis is usually long delayed.

The existence of a bronchial fistula is not a contraindication to opening up the supraphrenic focus from the exterior; on the contrary, a free external opening and good drainage are the surest means of preventing the septic intoxication which is commonly associated with incomplete evacuation by the air passages; care must be taken to make the pleurotomy very low down, to approach the abscess cavity from below, and to respect the

adhesions which shut off the rest of the pleural cavity. These precautions are necessary because such "air-containing abscesses" are usually very septic.

Interlobar Empyemas.—These are practically *intrapulmonary abscesses*, and what we are about to say regarding them applies equally to *pulmonary abscess, suppurating hydatid cysts*, and *localized gangrene of the lung;* further, the clinical differentiation of these various affections is often impossible.

We are indebted to Rochard for some interesting information regarding the direction and relationships of the *interlobar fissures:* he has shown that it is necessary to resect the 5th and 6th ribs in order to reach the oblique fissures, and the 4th rib to get at the short horizontal fissure which separates the upper and middle lobes on the right side;[1] but practically these guides are by no means always applicable, particularly as the normal topography of the fissures may be considerably disturbed by the presence of the interlobar effusion. While therefore due consideration is given to the anatomical indications, it is wise to take the *signs obtained by auscultation and percussion* as the chief guides, and to make the incision over *the centre of the dull area.*[2]

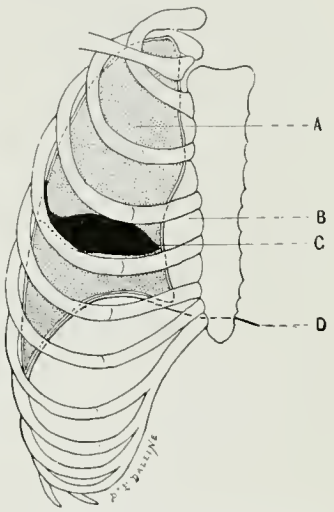

Fig. 235.—Interlobar empyema (diagrammatic). (A) Lung. (B) Mediastinum. (C) Interlobar abscess. (D) Diaphragm.

The diagnosis of an interlobar abscess is difficult, and the condition is sometimes met with unexpectedly during the course of a pleurotomy commenced in the ordinary manner. An incision has been made, say, in the 7th space, the lung is found adherent and the pleura thickened, the adhesions are separated within the accessible area, without pus being found or anything which resembles a fissure. However, the lung is tense, indurated, and resistant, and before the operation was begun, pus had been discovered at this level by the exploring needle. Create more room by resecting the rib lying above the incision, and make another puncture with a needle or small trocar, but do not attach an absolute value to the results of the puncture; if pus is found, well and good; but if the puncture is negative no certain conclusions can be drawn, and the operation must go on. Incise the surface of the lung for a length of an inch or an inch and a half, with the thermo-cautery knife at a dull red heat, and carry the incision steadily into the mass of the organ: generally the pus is not far away, and will soon

[1] Through the opening "the black line of the fissure should be looked for and can fairly often be seen." (Rochard, *Topographie des scissures interlobaires du poumon*, 1892.)

[2] See M. Dieulafoy's lectures, "La pleurésie interlobaire (étude médico-chirurgicale.)" *Clinique de l'Hôtel-Dieu*, 1898–1899, pp. 26 and 46.

be seen beginning to escape along the knife-blade ; the cavity will then be freely opened up, thoroughly emptied, and drained.

A tunnel going down to the hidden focus can be made quite well through the condensed lung tissue *with the finger :* there is very little bleeding. On many occasions we have followed this plan in attempting to reach a patch of pulmonary gangrene. The visceral pleura and a thin layer of the lung cortex are divided for a small extent with the scalpel, and the index finger is then pushed slowly into the lung tissue with a boring movement.[1]

Even in cases where the operative treatment is difficult, with a determination to open the abscess, the presence of which has been demonstrated by a preliminary puncture and with an adequate costal resection, the task can usually be carried to a satisfactory conclusion. But it will be satisfactory only if the two following conditions are fulfilled : **complete evacuation** and **good drainage.**

Mediastinal Abscess.

Mediastinal suppurations are uncommon, and the diagnosis is very difficult ; they are very serious affections, and early operative measures are urgently necessary : the methods of access vary according to the position of the abscess, and ought to be known.

Abscess of the Anterior Mediastinum.[2]—While these remain limited to the mediastinum, their recognition is usually very difficult :[3] localized retrosternal pain, increasing dyspnœa, the intensity of which is not explained by the results of auscultation, and presternal and peristernal œdema are the most valuable signs. Œdema in particular when present is a sign of great value : the point where it first shows itself, at one side of the sternum, may decide the position where the operation shall be performed.

These abscesses may burrow through the thoracic wall and present themselves under the skin, most commonly in the 2nd left intercostal space

[1] I take it for granted that the lung is adherent, that being the usual condition in these cases of intra-pulmonary suppuration, and that the incision has come down on this adherent area ; it may be however, that the conditions are not so simple, and that the free pleural cavity is opened. There is no serious harm done : plug the opening in the pleura quickly with a fold of gauze, then slip a pair of forceps obliquely under the gauze, catch hold of the lung and draw it into the wound, which it now occludes ; then explore all round the pulmonary surface with the finger : very often an area will be found quite close to the opening which is adherent to the wall ; work in that direction by incising the pleura, and if necessary excising another rib ; suture the segment of lung which had been brought into the wound, to the pleura, so as to shut off the free cavity, and finally open the abscess. The operation is certainly much more difficult when adhesions are absent ; that, however, is scarcely ever the case in extensive inflammatory lesions.

[2] These are much the most common : Hare, in 36 cases of acute suppurative mediastinitis, found 30 of the anterior mediastinum, 4 of the posterior mediastinum, and 2 cases of diffuse suppuration involving the whole mediastinal space. (*The Pathology, Clinical History, and Diagnosis of Affections of the Mediastinum.* Philadelphia, 1889.)

[3] These abscesses are often due to diffusion of deep-seated suppuration of the neck, or they may develop as a result of perforating septic wounds of the parasternal areas, or through infection of retrosternal hæmatoma resulting from fractures of the sternum ; or lastly, they may occur without evident direct cause after some infectious illnesses.

and close to the sternum. Therefore it is advisable to think of a possible mediastinal origin in some cases of deep subpectoral abscesses of the anterior thoracic wall. A man fifty-eight years of age was admitted to the surgical clinique at Gratz with the diagnosis of "abscess of the thoracic wall;" in front of the sternum and a little to the right there was a prominent, rounded, reddened swelling as large as the fist, and with great œdema over and around it. The abscess was incised and a stream of pus escaped and continued to spurt out from the depths of the cavity in jets synchronous with the respiratory movements; further investigation discovered a large opening between the manubrium and the body of the sternum, which led backwards into the retrosternal space: the anterior portion of the 2nd right rib was resected, exposing a large mediastinal focus, which was emptied, cleansed, and packed. Eight days previously the man had received a blow on the front of the sternum, and the resulting unrecognized fracture had been the point of origin for the trouble.[1] In such a case the treatment becomes a comparatively simple matter as soon as the orifice of the deep communication is discovered.

It is very different when the abscess is still confined to the mediastinum. Trephining the sternum over the dull area is then a reasonable, and one might say a classical, procedure: the bone is exposed by a longitudinal incision, and the opening at the point selected made with the trephine or burr, and, if necessary, enlarged with the gouge-forceps. But it is simpler, and almost always possible, to follow the parasternal route.

Almost invariably the abscess approaches one side or the other of the sternum, and at that point œdema appears: therefore examine the margin of the bone at the level of the œdematous area: pressure on it will provoke an acute fixed pain: at the inner extremity of one of the intercostal spaces the tense, thickened wall will be felt, and sometimes even deep-seated fluctuation may be detected; at this point, if necessary, make an exploratory puncture, directing the tip of the needle inwards and downwards. If pus is found, make an incision along the corresponding costal cartilage, detach it from the border of the sternum, and after freeing its deep surface, bend it outwards and divide it at the costo-chondral articulation; the abscess may then be opened along the sternal border.[2] If it is very large, augment the incision by another passing transversely outwards, the two cut ends of the internal mammary being caught and tied; a second cartilage may also be resected, and part of the sternal border cut away with gouge forceps.

The abscess cavity will be emptied and very gently cleansed with gauze swabs mounted in holders—or better still by irrigation without pressure—and then drained.

Abscess of the Posterior Mediastinum.—We will here describe the method recommended by Potarca,[3] for opening collections of pus in this

[1] V. Saar, "Zur Kenntniss der traumatischen Abcesse des Mediastinum anticum." *Beiträge f. klin. Chir.*, 1898, 417-21, p. 174.

[2] The pleural cul-de-sac is usually pushed outwards by the retrosternal abscess.

[3] J. Potarca, of Bucharest, *La chirurgie intra-médiastinal postérieure*. Paris, 1895.

region (peri-œsophageal abscess, etc.), presuming that we have to deal with a posterior mediastinal abscess which is to be opened on the right side.

Make a vertical incision from the 2nd to the 6th rib, midway between the vertebral border of the scapula and the line of the spinous processes, and at either end of the primary incision make two shorter transverse cuts. Cut and dissect up two flaps consisting of skin and muscles, and expose the 3rd, 4th, and 5th ribs. On each of these, clear and resect in the usual manner a segment about two inches in length, extending in the direction of the vertebral column as far as the tip of the corresponding transverse process. Cut and tie the intercostal vessels, then with the finger and director open up and retract the remains of the costal periosteum and the intercostal muscles. The pleura is now exposed. Next proceed to separate the costo-mediastinal layer of pleura very gently from within outwards with the tips of the fingers; continue the separation up and down the vertebral column for the full extent of the wound: with great care the membrane is detached and pushed aside (*Fig.* 236) and the mediastinal space opened;[1] the depth to which one must go will naturally vary according to the situation and character of the abscess.[2]

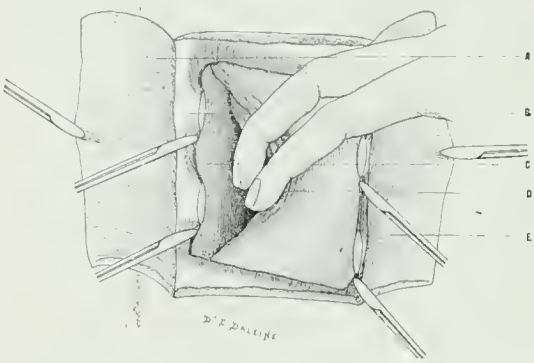

Fig. 236.—Posterior thoracotomy in the right latero-vertebral space; opening an intramediastinal purulent collection. (A), (E) Retracted musculocutaneous flaps. (B) 3rd rib, resected. (C) Side of the spine. (D) Pleura stripped up and held back with the fingers.

The principal accident to be feared is tearing the pleura, and the consequent entry of pus into the serous cavity; there is undoubtedly sometimes considerable difficulty, when the abscess is situated deeply in the mediastinum, in separating the membrane widely without perforating it; by working slowly and methodically any extensive tear can be avoided; but should the pleura be accidentally perforated, the opening must be covered at once with a fold of aseptic gauze to prevent the entry of air and pus into the cavity.

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[1] See the cases of Ziembicki, Krynski, and Obalinski (abscesses in the posterior mediastinum opened by right latero-vertebral thoracotomy) in Potarca's article, which has been already quoted. See also the description of the operation performed on the cadaver by Potarca: the patient had died before operation: an enormous intra-mediastinal pocket of pus was opened by the method above described. ("Rétrécissement cicatriciel de l'œsophage et abcès intra-mediastinal." *Presse médicale*. 11 juillet, 1900, p. 13.)

[2] If the collection of pus is situated towards the left, then naturally the thorax will be opened on that side, following the instructions given by Quénu and Hartmann. ("Des voies de pénétration dans le médiastin posterieur." *Bull. de la Soc. de chir.*, 1891, p. 82).

ABSCESS OF THE BREAST.

A simple mention of the sub-areolar abscesses is sufficient—small, red, fluctuating swellings, having the appearances of an aborted boil, and which should be opened by a prick with the point of the knife.

Subcutaneous abscesses, projecting prominently, and markedly fluctuant, also require no detailed attention: they should always be opened by the radiating incision presently to be described. It should not be forgotten that they are often only offshoots of larger and more deeply-placed abscesses. Once the superficial accumulation is evacuated, examine the wall of the cavity; if an opening is found from which pus continues to flow, enlarge it freely with the director. If the second focus is large, and placed at a lower level than the first, a counter-opening will be required (*see Fig.* 238).

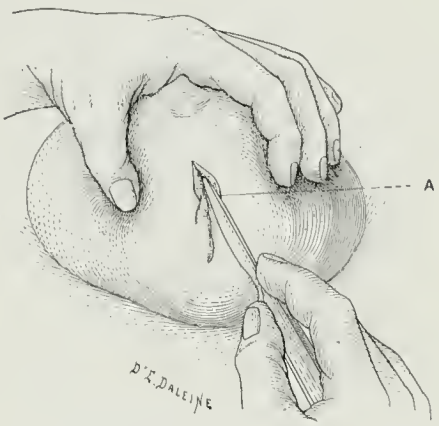

Fig. 237.—Radial incision of an abscess of the breast. (A) The scalpel, after having punctured the abscess, completes the incision.

The intraglandular abscess—abscess of the breast, properly so-called—occurring in the puerperium or during lactation, begins as a hard, ill-defined painful nodule in the substance of the gland, and often preserves these characters for a considerable time.

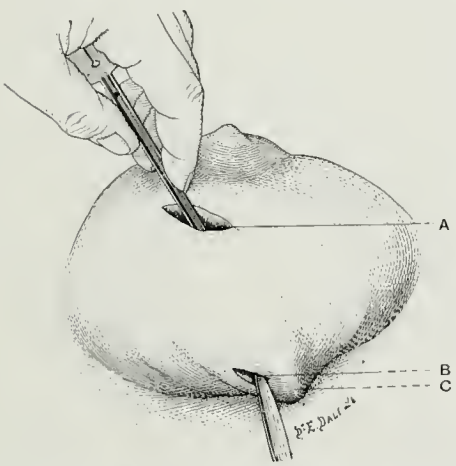

Fig. 238.—Counter-opening in an abscess of the breast. (A) Director, introduced through the first incision. (B) The scalpel making the counter-opening in a dependent position, over the tip of the director (C).

Do not wait for definite fluctuation; it is correct in the early stages to try to bring about absorption by elevation of the breast and the application of moist dressings, and under such treatment considerable intra-glandular patches of œdema may disappear; but if the nodule is enlarging, becoming more and more painful and lancinating, if there is fever, if the skin is œdematous and streaked with red, one may be sure that there is pus in the thickened mass, and probably much pus; therefore incise it.

Always make the incision in a *radial direction*, in other words, along a line radiating from the nipple towards the circumference of the breast (*Fig.* 237); not only will fewer of the milk-ducts be cut, but also fewer blood-vessels, and consequently there will be less bleeding. Incise at once right down to the centre of the inflammatory mass; there is absolutely nothing to fear, and in this manner alone can the task be performed satisfactorily. The operation is very painful; an anæsthetic is therefore necessary; one may use local anæsthesia, ether, or ethyl chloride. In making the incision use a narrow-bladed knife with a sharp point and a keen edge. Make a puncture at the centre of the swelling and enlarge the opening by cutting outwards for a sufficient distance. Short incisions are desirable in order to avoid unnecessary scarring; but an abscess which is badly opened in the first instance always produces the worst scar in the end. Make the incision sufficient to allow of the abscess being completely emptied and properly drained: avoid the rough and irrational method of a small puncture followed by forcible expression of the contents. With a good incision and a little gentle pressure the abscess ought to empty itself. Examine the cavity with the director and see if there are any prolongations, particularly in a downward direction. If so, push the point of the instrument against the skin in a dependent position as shown in *Fig.* 238, and make a counter-incision over it. A drainage tube passed from one opening to the other with forceps completes the operation.

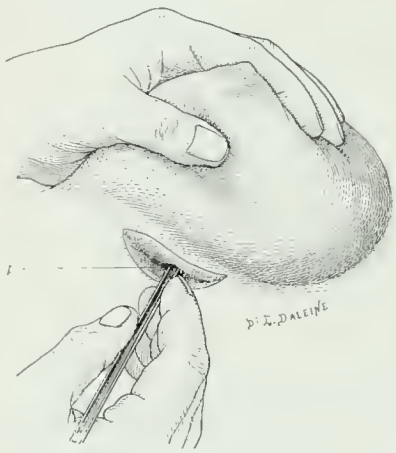

Fig. 239.—Incision of a retromammary abscess. (A) Opening up the deep-seated abscess cavity with the director, after a short incision in the submammary groove.

Not uncommonly the purulent foci are multiple, and several may have to be opened. The earlier the incision is made the less will have to be done.

Retromammary abscesses are occasionally seen: they are situated behind the breast, and lift it up bodily; the swelling, œdema, and redness first appear in the submammary groove. It is there, below and externally, and in the direction of the groove, that the incision should be made (*Fig.* 239).

In some forms of *diffuse suppurative mastitis* the breast and the whole mammary region are infiltrated with pus; in such cases isolated incisions of the more fluctuating points are insufficient; counter-openings must be made, and the breast drained from the centre to the periphery along several meridians.

Whatever the gravity of these forms of diffuse suppuration, the prognosis is much more favourable than in the *true diffuse cellulitis* (diffuse

phlegmon) of the breast, an affection which is fortunately very uncommon. I have seen a fatal case in a young woman, whose left breast, enormously swollen, sloughed in great blackish, fœtid masses, with only the slightest formation of pus. The great swelling, the diffuse œdema, the dusky redness and speedy blackening of the skin, the rapid extension to surrounding regions, and intensity of the toxic symptoms, enable this diffuse gangrenous mastitis to be recognized. The only resource consists in the immediate application of the treatment we have already recommended when speaking of diffuse submaxillary cellulitis, that is, free and deep opening up of the infected area with the thermo-cautery, by means of incisions extending to the limits of the swelling, combined with multiple punctures.

SECTION V.—THE SPINE.

Injuries of the spine, even in their milder forms, are a source of serious anxiety, and the prognosis cannot be too guarded. Some are attended by an immediately fatal result, as in section or crushing of the cord above the level of the 4th cervical vertebra, or death may ensue at a later date from secondary lesions. In other cases life is preserved only at the price of definite incapacity, of varying type and degree. Very often, even when the accident is not followed at once by characteristic disturbances, there is reason for fearing the ultimate development of obscure cord lesions, the relationship of which to the initial injury is not easily traced, and which are exceedingly difficult to treat.

Moreover the uncertainty of the prognosis after spinal injuries is accentuated by the unsatisfactory nature of the therapeutic measures at our command.

WOUNDS OF THE SPINE AND OF THE CORD.

Wounds produced by *sharp instruments* and *firearms* require special study.

A stab with a knife or a dagger, etc., in the neck, back, or lumbar region, may open the spinal canal and damage the cord, even though the superficial wound is at some distance from the middle line: all depends on the direction and length of the wounding instrument. The immediate motor and sensory disturbances are the sole indications of involvement of the cord; they vary widely in seat and extent, according to the level and nature of the central lesion.

From the point of view of immediate treatment, two possibilities may present themselves: (1) *The instrument has been left in the wound*, usually broken off short; (2) There is a simple deep wound, of variable extent, *without any foreign body*.

In the first case, the extraction of the instrument or its fragments must be undertaken as soon as possible. If projecting, or sufficiently prominent to allow of a good hold being taken, it will be extracted by steady traction in the direction of its axis with strong forceps; if flush with the skin, or if it can only be felt in the depths of the retro-vertebral muscles, the superficial wound must be opened up, so that the object may be clearly seen and properly grasped: by this means only is it possible to avoid the dangers and the fresh lesions which may be produced by a sharp blade for instance, badly held, dragged in wrong directions.

perhaps even driven deeper in. The wound will then be carefully cleansed, lightly packed with gauze, and covered with a large dressing.

Profuse discharge of cerebrospinal fluid has been observed after these extractions. In a case reported by Giss[1] the patient had received a knife-stab in the back of the neck between the 6th and 7th cervical vertebræ, and the blade, broken off, had remained in the wound. It was extracted at the end of three days: extraction was followed by an abundant flow of cerebrospinal fluid, the daily quantity of which was not less than four or five pints. The track remained open for five weeks, and during that time the total loss of fluid was estimated at over fifty pints.

When there is no foreign body, interference should, as a rule, be limited to carefully cleansing the superficial part of the wound and the area around it, and to applying a protective dressing. No sutures should be introduced. Primary opening up of the wound will very seldom be indicated: indeed, to succeed in efficiently cleansing so deep a wound track, it would be necessary to make such a large opening and perform such a troublesome operation that too often the dangers would only be aggravated.

These rules apply equally in the treatment of gunshot wounds. If the projectile has caused much injury to the bones, it will be advisable, by enlarging the wound of entry, to open up the focus, and to extract any fragments of bone which might compress the cord. Apart from this particular indication, no interference is advisable, at least at the outset, and one will also refrain from any investigation or exploration with probe or finger; such measures can give no useful information, and are, in this region, doubly dangerous.

Subsequently, if the presence of the bullet in the spinal canal is demonstrated by radiography, it will be good practice to remove it without too much delay. The ultimate results will always depend on the nature of the medullary lesion and the secondary degenerations.[2]

FRACTURES OF THE VERTEBRAL COLUMN.

These are grave injuries, often irremediable and hopeless. The cases are too numerous and too uniform in character to permit of any illusion with regard to the gravity of the lesion: after a fracture of the spine, the future depends almost exclusively on the primary injury of the cord; the damage is done at the moment when the fracture occurs, and the symptoms run their fatal course.

Undoubtedly if the cord has not sustained too violent an injury at the time of fracture, if it is merely compressed, or stretched over a projecting bony angle, early operation may, by liberating it, restore its functional

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[1] Giss, "Ueber einen Fall von Abfluss colossaler Mengen von Cerebrospinalflüssigkeit nach Rückensmarksverletzungen." *Mittheil. aus der Grenzgeb. der Med. und Chir.*, Bd. viii., Hft. 4 & 5.

[2] See Walther, "Plaie de la moelle par arme à feu." *Bull. de la Soc. de chir.*, 1901, p. 1084.

continuity. These operations, however, are dangerous and difficult, and we are much less able to deal with severe spinal compression than with the corresponding cerebral condition.

The last word, however, has not been said on this subject, and it is the writer's opinion that we shall ultimately succeed in evolving operative indications which will enable us to reduce the hopeless cases to those with anatomically irreparable lesions. At the present time the conditions justifying early surgical intervention are not often realized.

The following is the manner in which, from a practical standpoint, this difficult and serious question presents itself to the writer :—

1.—In any case of vertebral injury it is necessary to conduct the *transportation* and *examination* of the patient as if a complete fracture of the spine had been demonstrated. These "spinal cases" ought to be handled with the utmost care, if one wishes to avoid sudden displacements and angulations which may result in instant death, or at any rate in irreparable aggravation of the primary lesions. The patients ought to be raised and moved *en masse*, by a sufficient number of assistants, working together at the word of command.

In transferring the patient from the stretcher to the bed employ the following plan :[1] An unyielding bed is necessary, made up of one or two firm mattresses, with boards placed underneath, between the mattress and the bedstead ; the stretcher is carried to the foot of the bed, and placed in line and level with it. Six assistants are required to lift the patient, three on either side ; the two first slip their hands under the patient's shoulders ; the second pair under the loins and pelvis : the third pair under the thighs and legs. If the injury is situated in the upper part of the spine, a seventh (the doctor himself) takes charge of the head. At the word, the patient is gently raised to a sufficient height ; then the three pairs of bearers move together from the foot to the head of the bed, and place him down slowly, without jolting. It then only remains to cut off the clothes and to complete the examination, exercising the same caution as before. Naturally, if there is no paralysis, if all four limbs have preserved their motility, one may approach the task with fewer misgivings ; still, until definitely assured of the condition of affairs, and until a thorough examination has enabled one to conclude that there is no lesion of the cord or fracture of a process, or vertebral fracture without displacement, too great care cannot be exercised. This definite and conclusive examination cannot be made, and ought not to be attempted, until the patient is in bed.

If after due examination one is satisfied that the cord is not damaged, and that the vertebral lesions have affected only the posterior arch and are not complicated by any notable depression, all that remains is to keep the patient flat on his back in bed and absolutely immobile : accident and treatment are alike simple.

[1] Recommended by Albert, of Vienna.

2.—The problem is very different when **signs of serious cord lesions are present, but without evident spinal deformity.**

The sole immediate indication is for *immobilization*, in the manner presently to be described ; it will only be at a later date that the evolution of the nervous symptoms will permit an opinion being expressed with regard to the prognosis.

The absence of any evident deformity (in stout patients the examination is sometimes difficult and the results are uncertain) is not sufficient to exclude the possibility of bony compression, and the lesions of the vertebral bodies are too varied in type to allow of the state of the canal being always correctly gauged by the irregularities of the posterior arch. The cord may have been bruised or crushed beyond hope of recovery, at the moment of injury, without any displacement of the fragments having persisted. At this stage it is impossible to know anything with regard to these two possibilities; but in such cases the sensorimotor paralysis and the loss of sphincter control are complete, the deep reflexes are abolished,[1] and trophic symptoms speedily make their appearance.

It must not be forgotten, however, that this group includes a certain number of cases in which spontaneous recovery is possible, notwithstanding the fact that at the first examination most characteristic signs of cord lesions are evident. Such recoveries are almost invariably associated with *low injuries* in the *lumbo-sacral region*, but sometimes with fractures in the lower cervical region ; in the dorsal region the small calibre of the spinal canal gives the cord very little chance of escaping grave injury in case of fracture.

Case 14.—A slater, aged 27 years,[2] had fallen backwards from the third storey, alighting on the buttocks. There was flaccid paralysis and complete anæsthesia of both lower limbs ; retention of urine and obstinate constipation ; very extensive ecchymosis in the sacrolumbar region, extending to the scrotum and the hypogastrium ; pressure over the right wing of the sacrum caused acute pain, and at the same level there was a slight depression ; no other deformity was discovered. The patient was placed in Bonnet's spinal trough. At the end of a month there was improvement in the sphincter condition, fifteen days later some alleviation of the paraplegic symptoms was observed ; sensation returned first, then motor power very gradually, until all movements could be performed. In short, at the end of five months the patient was able to resume work ; two and a half years later he was still following his occupation as a slater.

Case 15.—A man had been knocked down by a heavy vehicle and was taken to the Beaujon Hospital, where I saw him some hours later. There was then complete paraplegia, sensation and motor power being both abolished, and retention of urine. A very acute pain was caused by pressure in the lumbar region at the level of the 3rd vertebra, and a moderate degree of projection of the corresponding spinous process was detected. The patient was immobilized in Bonnet's spinal trough. No improvement occurred during the

[1] This is a sign of very particular value : if the tendon reflexes are preserved, even partially, a complete and irremediable lesion of the cord may be excluded ; but their absence during the first few days is not in itself conclusive, as the loss may be transitory.

[2] This case was mentioned in our paper : "Curabilité des traumatismes rachidiens." *Gaz. des Hôp.*, 2 juin, 1894, No. 64, p. 594.

first six weeks: then sensation slowly reappeared, and some movements of the feet and legs became possible. Electrical treatment was persistently carried out; at the end of four months the patient could walk.

Such fortunate and often unexpected results are undoubtedly to be explained by the special nature of the central nervous lesions: the condition is either one of compression of the cord by blood effused into the spinal canal (hæmatorachis)[1] or of contusion, not of the spinal cord itself, but of the nerves of the cauda equina, much more resistant than the cord, and also possessing considerable power of structural and functional repair.[2]

3. Lastly we may find the following and most common condition: there are **signs of serious cord lesions,** paraplegia, perhaps paralysis of all four limbs, etc., and there is also **well-marked spinal deformity.**

What is the prognosis? What is to be done?

The prognosis is unfortunately only too certain, for although a few instances of recovery or partial recovery may with considerable difficulty be collected, the histories of these cases are repeated with almost hopeless uniformity. Death is inevitable, at the end of some weeks, two, three, six months perhaps, after more or less prolonged suffering associated with incontinence, œdema, bedsores, cystitis, pyelonephritis, etc.

This is the result, which must be foreseen and which will almost inevitably occur if nothing is done—if one is content with immobilizing as well as one can the broken and distorted spine. Undoubtedly in that way one can prevent the sudden accidents, sudden death, which might result from further displacement of the fragments, and also, up to a certain point, any aggravation of the primary lesions of the cord: but the compression remains as it was; indeed, by immobilizing the patient the compression is perpetuated.

On the other hand, it is quite evident that nothing can be known with absolute certainty with regard to the state of the cord at this stage; the paralysis and the spinal deformity are observed, and naturally they are associated together. But what is the association? What are the actual lesions? Is the cord merely compressed? Is it ruptured? Is the affected spinal segment destroyed beyond chance of recovery? Is any operation necessarily hopeless, and may it hasten the fatal issue?

There is no answer to these questions: hence the reason why it is so difficult to arrive at a decision in these cases, the more so as operative

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[1] An intraspinal effusion of blood may express itself, as in the corresponding cranial condition, by delayed and progressive symptoms. Sonnenburg relates the case of a man who fell from his horse. He got up unaided: there was no wound and no paralysis. On the following day both lower limbs were completely paralyzed, but the plantar reflexes remained: there was fæcal incontinence and abdominal hyperæsthesia. By the second day the reflexes were weaker; on the fourth day there was abdominal distention, and on the fifth day paralysis of the upper limbs; the patient died on the seventh day. A large hæmorrhagic effusion was found between the vertebral canal and the cord. (Sonnenburg, "Die Halswirbelbrüche." *Deutsche Zeit. f. Chir.*, 1892, Bd. xxxiv.)

[2] Spinal concussion, as described some years ago, can scarcely be demonstrated. In addition to the benign form, characterized by disseminated, irregular, incomplete, and transitory paralytic symptoms, another and rapidly fatal variety, of which Schmaus and Sonnenburg have reported several instances, is occasionally met with.

measures are in themselves dangerous and difficult, the results doubtful, and past experience discouraging. It is therefore impossible to lay down any definite rules. We know so well, however, what is implied by non-interference, that we should try to do everything possible in a given case.

(*A*).—**Fractures of the Cervical Spine.**—An example will show the extreme gravity of these fractures and the necessity for immediate immobilization after reduction.

Case 16.—The patient was a man 35 years of age, who, on the evening of October 1st, 1900, had fallen backwards on to his head from a height of three or four yards; he lay outstretched and motionless; he was taken to the hospital, and on the 2nd of October I found him in the following condition: there was complete flaccid paralysis of all four limbs, except that the movement of flexion of the forearms remained; complete anæsthesia of the lower limbs and the

Fig. 240.—Apparatus for immobilizing the cervical spine. A plaster band encircles the head, crosses behind the neck and again in front of the chest, and is fixed by turns of another plaster bandage passing around the chest. A strengthening band includes and supports the lower border of the jaw.

Fig. 241.—Apparatus for immobilizing the cervical spine, including the whole neck and adapted above to the lower border of the jaw and the occiput. A band encircling the forehead would be a useful addition.

trunk up to a transverse line crossing the manubrium sterni and extending out on either side to the deltoid regions; anæsthesia of both upper limbs except for symmetrical bands on the postero-external aspects and in the long axes of the limbs, extending from the deltoid region to the forearms, thumbs, and index fingers. The patellar and cremasteric reflexes were abolished on both sides, the plantar reflex on the left. Retention of urine. Temperature 101°. At the base of the neck, opposite the 6th vertebra, a slight depression was discovered, over which pressure caused acute pain: curiously the pressure at that spot produced a strange symptom which was repeatedly verified, viz., erection.

The head was kept carefully fixed. In the evening the temperature was 103°, the following morning 104°; in the evening nearly 106°; at 8.0 o'clock the patient had a black vomit; at 9.0 o'clock he was comatose; at midnight he was dead. At the autopsy a comminuted fracture of the posterior arches of the 5th and 6th cervical vertebræ was found.

The rapid evolution of this case indicated a serious and irremediable lesion of the cord: it is none the less true, however, that death had been retarded by the early and continued application of extension.

As Chipault[1] has conclusively shown, cervical fractures are almost invariably complicated by dislocations, and for that reason reduction should always be practised, by the method and with the precautions which will be presently described.

Reduction is usually associated with a sensation of crackling and a jerk as the bones slip into place; often, if the fracture is comminuted as in the case just described, only a slight effort is required to effect reduction; but on the other hand, in such conditions the displacement only yields to return immediately.

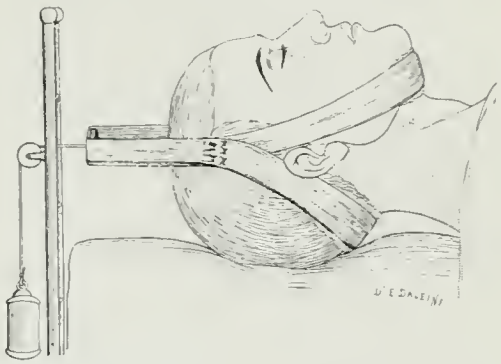

Fig. 242.—Continued extension of the cervical spine.

Cervical immobilization must therefore be assured at once by the application of a retentive apparatus (*Figs.* 240 and 241), or by continuous extension (*Fig.* 242). The latter method is preferable in the comminuted fractures of which we have just spoken.

(*B*).—**Fractures of the Dorsal and Lumbar Spine.**—Whether the condition is one of depression of the laminæ or of complete fracture with acute angulation of the vertebral column, it must be admitted that all manual and mechanical attempts at reduction give, only too often, very unsatisfactory and deceptive results.

Direct reduction, by extension and counter-extension, with forcible pressure over the spinal prominence, necessitates such forcible and dangerous manipulations, and is so seldom efficacious, that it cannot be recommended. There are two other methods, associated with much less risk but equally uncertain in their results: *continuous extension* and *cervico-axillary suspension*.

Continuous extension is applied through the two lower limbs, in the lower thirds of the thighs, after Hennequin's method, which is described elsewhere (see FRACTURES OF THE THIGH), and the counter-extension through axillary loops, the patient lying stretched out flat on the back in bed. Or again, following Malgaigne's practice, the weight of the body may be used as the extending force, the head of the bed being raised and the patient prevented from slipping down, as before, by counter-extension applied through axillary loops.

[1] CHIPAULT. *Etudes de chirurgie médullaire*, 1894.

With regard to **Cervico-axillary suspension**, Sayre's tripod is required for its correct application. A pulley fixed in the ceiling may, however, be used instead of the tripod if the latter is not available. The patient is raised to a sitting position on the bed, great care being exercised, and firmly and steadily supported, while the axillary loops and the double sling which passes under the jaw and the occiput are fitted. Traction is then slowly and progressively applied, and ought to be increased until the deformity disappears and the spine recovers its normal contour; that object is, however, sometimes unattainable. It is also to be remembered that the reposition, which to external examination is apparently complete, is not an unfailing indication of accurate adjustment of the fragments, or restoration of the lumen of the spinal canal. However that may be, once reduction is obtained, a plaster jacket, carefully padded over bony prominences, should be applied forthwith.

The inadequacy of these methods, still more of simple immobilization, and the usual unfortunate outcome of these vertebral injuries, are the three most powerful arguments in favour of **immediate operative intervention.**

The operation cannot be considered an easy one, and further, the results which have been obtained up to the present time are by no means convincing. However, in the case of *fracture with depression of the posterior vertebral arch*, the indication, as in the corresponding cranial condition, is for immediate operative treatment, at whatever level the lesion is situated. Moreover, if the fracture is compound (gunshot injury, crush, horsebite, etc.), the need for immediate operation is indisputable.

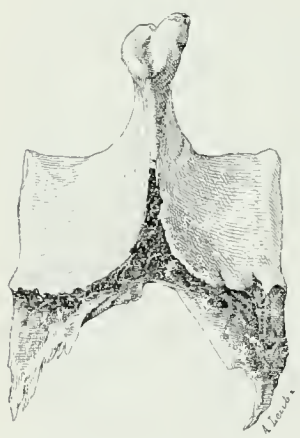

Fig. 243.—Posterior arch of the 7th dorsal vertebra, removed by operation after fracture.

Case 17.—A girl, 17 years of age, 4 months pregnant, threw herself from the third storey: she was brought to the Hospital Tenon. Next morning I found a condition of complete paraplegia, with anæsthesia to the level of the iliac spines; retention of urine; acute pain to pressure in the middle line of the back at the level of the 7th dorsal vertebra, and at the same point a well-marked spinal depression; there was also a fracture of the left arm. Immediate operation was decided on. The posterior arches of the 6th and 7th dorsal vertebræ were exposed by a long incision: the 7th arch was loose and somewhat depressed into the spinal canal; the spinal process was intact, and it served as a point for the application of traction, while the detached fragment was freed and finally extracted (*Fig.* 243). Some clots were removed from the spinal canal; the dura mater was found to be lacerated and the cord a little flattened, but free from any pressure, and there was no projection of the anterior wall of the canal.

The opening in the dura mater was closed by two fine catgut sutures; the spinal muscles were brought together by a few sutures and the skin wound closed without drainage, and covered in by an ample dressing over which a plaster jacket was applied. The wound healed normally, without

any complications; but there was no improvement in the medullary symptoms; bedsores, purulent cystitis, and pyelonephritis developed; two months later the patient miscarried and was delivered of a dead child, and in the third month she died.

We cannot give the technique of laminectomy at length; it has been very well described by Chipault.[1]

It is of capital importance to provide abundant room and to expose the spine freely. The patient is placed face downwards on the operating-table and supported with cushions so arranged as to make the part of the spine to be operated on as prominent as possible. An incision 4 ins. long is made in the middle line, extending equally above and below the seat of fracture. After the skin, the vertebral aponeurosis is divided on either side close to the spinous processes, from which the vertebral muscles are then detached, partly with the knife and partly with the elevator;

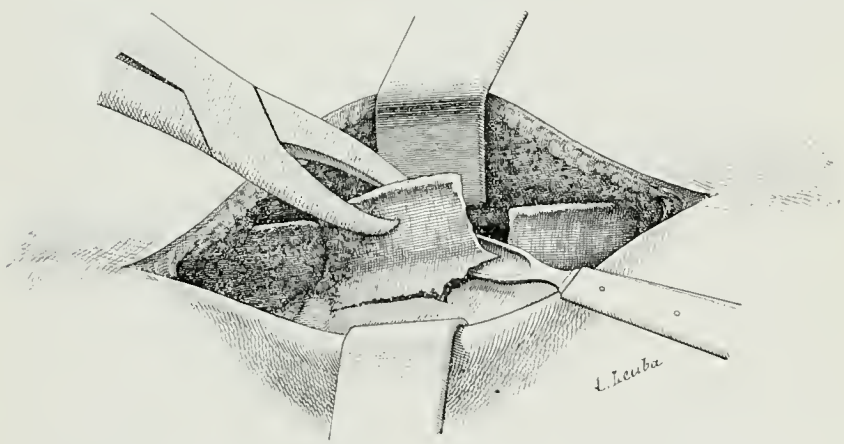

Fig. 244. — Laminectomy for spinal fracture. The spinous process, seized with lion forceps, serves to lift up the posterior arch, while the elevator frees it below.

the separation of the muscles must be continued until the vertebral grooves are completely exposed; the muscles must now be retracted outwards on either side with large retractors, and the exposed posterior surface of the spine be carefully examined. The lesions of the posterior arch vary in character: there may be a comminuted fracture, a depression of one of the laminæ, or of an entire posterior arch separated in one piece from the rest of the vertebra by fractures through or in the vicinity of the articular processes. An endeavour must first be made to ascertain the seat and direction of the different lines of fracture, the points where the fragments are raised above the general level or separated from the neighbouring bone, and see if a place can be found where the work of raising and extracting

[1] *Loc. cit.*

the fragments may be begun without danger of damaging the cord. If the case is one in which an entire posterior arch is driven in and incarcerated, seize the spinous process, or what remains of it, with lion forceps, and hold it up, so avoiding risk of further depression, while the end of the elevator slipped under the edges of the fragment completes its liberation (*Fig. 244*).

After the necessary extraction of bone, the vertebral canal and the cord are inspected: to be adequate the operation must not be limited to the mere raising or removal of a splinter of bone, but the whole area must be exposed; in particular the state of the spinal canal in its entire circumference must be determined, and any cause of compression of the cord removed.

If the lesions are limited to the posterior arch, the wound may then be closed and the spinal column immobilized in the way that we shall immediately describe.

The operation is much more difficult *in cases of complete fracture*, where the cord is found stretched over or compressed by the posterior projection of the fractured and displaced vertebral body. If the bony prominence cannot be restored to its proper position, it must be cut away with chisel and mallet, in order to restore the proper calibre of the canal. It is the injuries of this nature, the complete fractures, particularly in the dorsal region, which are least suitable for useful surgical intervention, the medullary condition present is from the outset irremediable, being usually contusion or crushing rather than compression.

After these operations, means must be adopted for immobilizing the vertebral column. Bonnet's trough still remains the type of the apparatus for spinal immobilization: when not available it may be replaced more or less adequately by a mattress raised up around the patient on either side like a trough. Before the patient is placed on the mattress a hole should be made in it, in a suitable position and of sufficient size to allow of the use of the bedpan, etc.; a wooden framework is placed below and around the mattress, the two lateral pieces being connected by a certain number of transverse bands; by means of this arrangement the patient can be raised when necessary, all of a piece, with the least possible disturbance.

The fixation may be obtained by means of a plaster jacket applied in the following manner: three broad plaster bands, long enough to go round the body, are spread across a table, the contiguous borders overlapping a little; under them, on the table, two or three linen abdominal binders will have been placed, which will presently serve to cover in the plaster corset and fix it in place. Then the patient, all bony prominences being carefully padded, is lifted bodily on to the plaster bed, with the precautions detailed at the beginning of the section; all that remains to be done is to fold the three segments of the apparatus around the trunk, and over them to apply and pin the binders, and leave the whole thing to dry.

DISLOCATIONS OF THE VERTEBRAL COLUMN.

We here limit ourselves to a brief description of the method applicable to the reduction of dislocations in the lower cervical region. These are the commonest of spinal dislocations, and it is with them that reduction has given the most satisfactory results.

The displacement is usually forwards; it is bilateral or unilateral, accordingly as the articular processes are separated on both sides or only on one; in the latter condition rotation is combined with flexion of the head.

The head is in a position of extreme flexion, the chin resting on the sternum; the nape of the neck is elongated and incurved and sometimes

Fig. 245.—Reducing a dislocation of the cervical spine.

intersected at the level of the dislocation by a depression of variable depth. Finally, symptoms of cord compression, in any degree of severity up to complete paralysis of all four limbs, complete the picture.

What is to be done in the presence of a recent cervical dislocation? "On the whole," wrote Malgaigne, "when one finds a patient with the head inclined forwards, and paralysis, more or less complete, of all four limbs, I think that the first thing to be done, even in the absence of any other symptom, is to carry the head backwards and to fix it there with the assistance of a suitable apparatus."

Reduction may be effected in either of the two following ways :—

1. The patient may be seated on the ground, and the shoulders being well fixed, *steady, vertical, progressively increasing traction be applied through the occiput and the chin*, which are grasped between the two hands of the operator.

2. It is often better to place the patient in the horizontal position, on his back, and to give an anæsthetic. This must be very cautiously administered, and to obviate any risk of the spinal lesion being aggravated by struggling during the induction, the patient must be securely fixed. Two or more assistants are required to exercise counter-extension.

The operator, standing behind, grasps the head *by the occiput and the lower border of the jaw*, as represented in *Fig.* 245, and pulls in the axis of the neck. The force must be applied gently, slowly, progressively, without any lateral flexion, without rotation, and steadily increased. A very powerful effort is often required ; it will sometimes be found well to use Sayre's apparatus as Dr. Aubert, of Mâcon, has done :[1] Sayre's collar was placed under the occiput and the chin and attached to the transverse rod, furnished with a central hook, used for suspension. A dynamometer was fixed to the hook by several turns of cord, and through the other end of the dynamometer a folded handkerchief was passed, and through this the extending force, obtained with the assistance of the pulleys of the suspension apparatus, was applied. The force was steadily and progressively increased up to 70 kilos (157 lb.) : reduction was associated with a loud tearing and crackling noise.

These cracklings and sudden jerks are mentioned in almost all the cases. It must be remembered that though reduction is certainly indicated and is the patient's only chance, yet it is associated with immediate danger which must be foreseen and mentioned.

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[1] Charles Aubert, *Contribution a l'étude des luxations des vertèbres cervicales. Quelques cas heureux de réduction.* Thèse de doct., 1889, No. 34.

SECTION VI.—THE ABDOMEN.

CONTUSIONS OF THE ABDOMEN.

A person has been knocked down by a vehicle, one of the wheels of which has passed obliquely over his abdomen; or he may have fallen flat on the ground, the abdomen coming in contact with some projecting object; or have been kicked by a horse, etc. The patient is found a few minutes after the accident with pallid face and anxious expression, the surface of the body covered with a cold sweat, speech broken, respiration shallow and rapid, and the pulse feeble; the abdomen, which may or may not present some signs of the injury, is almost equally painful over its whole surface. The patient is in a condition of *abdominal shock*. Of the nature of the deep lesions, one knows and can know nothing definitely at this stage; the force of the injury, its point of application, and the gravity of the general symptoms give only indefinite indications.

The shock must first of all be combated, and the situation will become clearer and the indications more definite in the hours which immediately follow.

Have the patient put to bed with as little disturbance as possible; cut off the clothing; place him with the head low, envelop his limbs in wool and, most important of all, give repeated subcutaneous injections of saline solution and caffeine. Watch the patient closely, do not leave him more than is absolutely unavoidable, because future action will be decided by what occurs during this initial period.

Immediate laparotomy has been spoken of as a routine procedure in these cases. But if the patient rallies well and quickly, if the character of the pulse and the facial aspect become satisfactory, if there is no increase in the abdominal pain and no distention appears, if flatus and urine are passed, what surgeon would insist on at once opening the abdomen? Cases of this kind in which spontaneous recovery ensues are well known, but to quote them in support of a general waiting policy, sometimes described as one of "armed expectancy," is illogical. We know that cases of *abdominal contusion without serious visceral lesions* do occur; they are the only cases which recover. Is spontaneous recovery possible after a rupture of the liver or the spleen, or after a perforation of the stomach or intestine? Practically we must answer no; exceptional cases, laboriously collected, merely prove the rule. The position may be summarized very simply: There is a series of deep abdominal lesions produced by contusion, in which

death early or late is the inevitable consequence in default of operative intervention. Further, if this intervention is to be undertaken with the best possible chances of success, it must be decided upon and carried out within the first few hours; it is therefore necessary to lay down the indications for operation, basing those indications on certain signs **which are not, and which ought not to be, the signs of peritonitis.**

Let us add that the miserable results of late operations—to which by force of circumstances we are too often reduced—are of such a nature as to make it necessary to add the following corollary to the general rule: **in doubtful cases the indications are for immediate operation.**

One or two hours have passed: the pulse remains feeble and rapid—120, 130, 140 to the minute: it improves after each subcutaneous injection of saline solution, but speedily weakens again; the temperature is subnormal (97° to 97·5°); the extremities and the tongue are cold; the patient is restless, anxious, and his respiration is laboured; the abdomen is becoming distended; it is rigid, the slightest pressure on any part of its surface is painful, but particularly in the area which has received the impact of the injury; there is dullness in one of the iliac fossæ, some degree of resonance in the hepatic region, neither flatus nor urine has been passed. With such conditions **operate at once; do not wait for vomiting or any other symptoms.**

A very serious operation has to be undertaken, it is true; but in another hour or so it will be still more serious, because the patient will be more anæmic or more infected; to-morrow, or perhaps by the evening, it will be too late. It is impossible to insist too strongly on the crushing responsibility which the practitioner assumes who waits for superfluous confirmation of the gravity of the symptoms.

The foregoing clinical example falls into the group of well-defined and typical cases. The picture is not always so complete, and the various symptoms have not all the same value, nor are they always combined in the same manner.

Amongst these signs two possess particular importance:—

1. **Permanent and progressively increasing weakness and frequency of the pulse,** usually associated with subnormal temperature, marked pallor, a condition of nervous anxiety, depression or restless excitability, the ordinary consequences of acute anæmia.

2. **Progressive distention of the abdomen, combined with tenderness and rigidity of the abdominal wall,** which hardens and "defends" itself on the slightest touch.

The pulse, to which we shall have repeatedly to refer when speaking of the surgery of the abdomen, gives invaluable information if carefully observed and analysed; for instance:—

Case 18.—A gardener, aged 35 years, was knocked down about three o'clock in the afternoon by a heavy wagon, which was stopped just in time to prevent the wheels from passing over his body; he fell flat on the abdomen

and lost consciousness. An hour later I saw him; he was very pale, with pinched features, the temperature was practically normal, but the *pulse was* 120, *and very feeble*. Pressure in the right flank elicited rather acute tenderness, and on oblique inspection of the abdomen a slightly marked prominence was observed in the same region; the rest of the abdomen was neither tender nor distended; palpation gave no definite information. Flatus had been passed per anum; the urine was slightly blood-stained. In fact there was nothing absolutely definite about the case, the wretched pulse alone attracting attention. It improved somewhat after a subcutaneous injection of saline solution; a quarter of an hour later, however, it was as bad as before, and after watching the patient for twenty minutes, it was quite evident to me that the depression of the pulse and the general enfeeblement were steadily getting worse.

This furnished *a certain indication of internal hæmorrhage*; laparotomy was therefore performed at five o'clock, and we found—no intestinal perforation, no rupture of any solid viscus, but a large quantity of blood in the pelvis and right iliac fossa. In the mesentery there were three large rents, and from the gaping vessels in the margins of the tears blood was still escaping.

It was in fact simply an internal hæmorrhage which had caused the *progressive* weakening of the pulse observed in the hours immediately following the accident, and internal bleeding thus revealed always demands immediate operative intervention.

In such a case **the pulse** is often a much surer guide than the thermometer: *when there is disagreement between the pulse and the temperature, it is the pulse which must be believed.* A subnormal temperature may depend on central nervous shock, and be therefore of quite different significance. I remember the case of a man who, six hours after having sustained an abdominal injury, had a temperature of only 96°, notwithstanding that all other signs of shock had long disappeared; there was no abdominal tenderness, the pulse was full, strong, and practically normal in frequency. I refrained from any interference and gave a very favourable prognosis, which was quite fulfilled; next morning the temperature had become normal.

Iliac dullness is also a valuable sign of internal hæmorrhage; but too much stress must not be laid upon it, because it is sometimes indefinite and not always easy to determine. The effused blood does not always accumulate and coagulate in the iliac fossa: often it runs into the true pelvis, particularly when the bleeding is taking place on the left side of the mesenteric folds; and further, the dullness may be obscured or altogether hidden by overlying distended loops of bowel.

Rapidly increasing abdominal distention is an important sign; and here again a close and attentive study of the patient during the first few hours alone permits an accurate appreciation of the condition. The distention develops very quickly, and sometimes a localized fullness, which quickly spreads and becomes generalized, may be first observed in the injured region. The hepatic dullness may also give place to an area of resonance.

An almost pathognomonic significance has been ascribed to the last-mentioned point as an indication of intestinal perforation or rupture; it is undoubtedly a valuable, but by no means a certain, sign; gaseous

distention of the stomach and the colon, and relatively small size of the liver, which is hidden under the base of the lung, may so far diminish the hepatic dullness as to prevent its detection; and the single fact that liver dullness is absent would not justify the conclusion that there was an intestinal perforation. Again we must emphasize the fact that each of the various diagnostic points only acquires its full importance from its place in the combination of symptoms. Often there is little or no distention of the abdomen, which remains flat with **tense rigid walls**, giving to the fingers the sensation of a *permanent contracture*.

The wall "**defends**" **itself** against the slightest contact; it can be felt to tighten on the least pressure, not only at the seat of injury but beyond, over the whole surface of the abdomen. We shall again have to speak of this defensive reaction of the abdominal wall in inflammatory affections, appendicitis for instance; it is always a most important diagnostic factor.

If the surgeon has been fortunate in seeing the case in its early stages, **on no account must he wait for the development of signs of infection**; let him seek for and carefully analyse the local signs indicative of internal hæmorrhage or intestinal rupture, at the same time according the utmost attention to the pulse, temperature, facial expression, the defensive reaction of the abdominal wall, and, above all, let him decide quickly, without insisting upon a demonstration of the deep lesions before operating. These lesions only show themselves definitely at too late a stage, when peritonitis has already commenced. An unnecessary operation is much less to be feared than the renunciation, or the postponement until "too late," of one that is of vital importance. The cases which are really benign commonly show themselves as such with sufficient clearness when the initial shock has passed off; if any doubt remains, it is always advisable to operate.[1]

As a matter of fact, the prognosis in these laparotomies depends on two factors: (1) *On the nature and number of the visceral lesions;* (2) *On the time, early or late, at which operation is performed:* in other words, on the absence or more or less limited extent of the infective changes.

The first factor is beyond our control; the second we are often responsible for, and therefore in a large degree responsible for the ultimate result.

[1] Guinard has proposed to make a "buttonhole exploration of the peritoneal cavity," that is to say, a small median sub-umbilical incision about an inch long, in doubtful cases; if blood or intestinal contents are found in the cavity, the incision will be enlarged and an ordinary exploratory laparotomy performed. (Guinard, *Congrès de chir.*, 1895 and 1897: also Malmejac, *Boutonnière exploratrice du péritoine dans les contusions de l'abdomen.* Thèse, 1897.) The operation can be performed under cocaine anæsthesia; it terrifies the patient less, and a positive finding may help the surgeon to overcome the patient's hesitation by affording, so to speak, a visual demonstration of the urgency of the condition and the need for an adequate operation. However that may be, it must be remembered that the dangers of a laparotomy are not to be measured by the length of the incision; further, when working through a small opening there is a serious risk of failing to recognize certain deep-seated lesions, and the operator will almost always be compelled, if nothing is found when the peritoneum is first opened, and if he wishes to make a satisfactory examination, to enlarge the primary opening, and in fact to make an ordinary exploratory laparotomy. It is worthy of note that in the majority of "buttonhole" explorations the results have been positive, blood or intestinal contents being found in the peritoneal cavity, and it has been necessary forthwith to carry out a complete operation.

Unfortunately the surgeon only too often comes upon the scene at a stage when **undoubted peritoneal infection is present**: the patient is vomiting everything he takes, perhaps the vomit is already stercoraceous, the abdomen is considerably distended, the pulse is fluttering, and the facial appearance bad; fortunate indeed if he does not find the subnormal temperature and coldness of the extremities which indicate a hyperacute form of peritoneal septicæmia, and condemn in advance, as practically hopeless, any operative measures. In these late cases the condition of affairs is only too evident, and one is sometimes inclined to ask, Is it not too late to do anything, especially when interference usually implies a long and difficult operation? In my opinion, however, the limits of operative indications should be extended as widely as possible; for although the results are very bad, still the occasional unexpected recoveries are sufficient not only to justify but also to impose this conclusion.

TECHNIQUE OF LAPAROTOMY IN CONTUSIONS OF THE ABDOMEN.

General Technique.—In these cases, as in all emergency laparotomies, there is much uncertainty as to the nature of the lesions; nevertheless the prognosis depends to an important extent on the technique followed. The patient has scarcely rallied from the initial shock, and may readily relapse; it is therefore necessary *to reduce as far as possible the duration of the general anæsthesia and of the operation*, and to protect him from all chilling influences.

The operation will be performed in a well-warmed room to which the patient will be transported with great care; he will have his lower limbs enveloped in wool, and the chest well covered. Everything will be ready for subcutaneous infusion of saline solution, which will be injected into the arm, from one to two pints being administered before the operation, and if the patient's condition is alarming, the infusion should be continued throughout the entire duration of the operative measures. By this **continuous subcutaneous infusion** we have many times succeeded in conducting to a successful issue very serious and urgent abdominal operations in patients whose general condition was exceedingly bad.

The administration of the anæsthetic must not be begun until everything is ready and the surgeon is washing his hands. Ether is the anæsthetic of choice; it is generally admitted to be a much less potent factor in causation of shock than chloroform; the presence of an open fire and numerous naked lights in a small room, appear to us the sole contraindications to its use. It must be given carefully and slowly, in the manner already described.

The abdominal wall will be cleansed in the ordinary manner, from the pubes to the xiphisternum, **over its entire surface**: it is

impossible to know beforehand how far it may be necessary to carry the incision.

Excluding the cases in which the injury has definitely affected the epigastric region, and in which the local pain and other symptoms point to a lesion in the supra-umbilical zone, as a general rule **a sub-umbilical median incision**, four to five inches long, will be made. Do not delay in the superficial layers, but apply forceps to any subcutaneous vessels which bleed, and divide the aponeurotic plane in the linea alba if the knife has come right down on it; if not, do not spend time in looking for it, but open the sheath of one of the recti muscles, the inner border of which must then

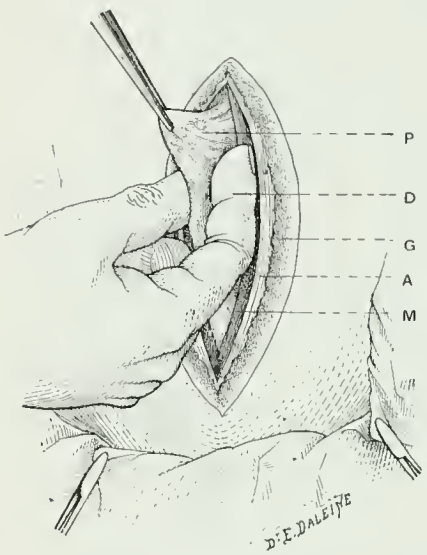

Fig. 246.—Infra-umbilical laparotomy. A fold of the parietal peritoneum is raised with the forceps, and the operator makes sure that it is perfectly empty. (P) Peritoneal fold. (D) Examining the fold with the thumb and index finger. (G) Subcutaneous fat. (A) Aponeurosis. (M) Rectus muscle.

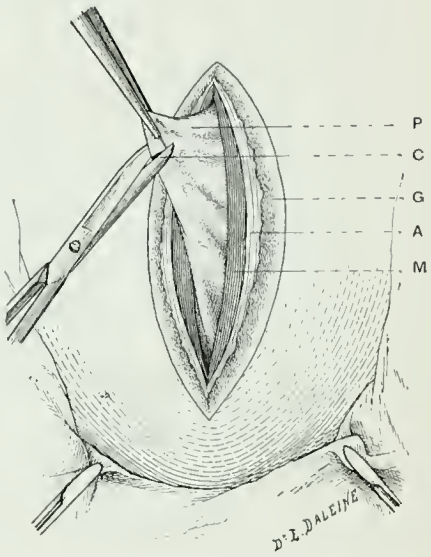

Fig. 247.—Infra-umbilical laparotomy. A small opening is made in the peritoneum. (P) Peritoneal fold raised and incised. (C) Scissors making the opening. (G) Subcutaneous fat. (A) Aponeurosis. (M) Rectus muscle.

be freed and retracted outwards. Pick up the deep fibrous layer, *the fascia transversalis*; raise it up, open it with the point of the knife or the scissors, and divide it on the finger, in the line of the wound.

The extra-peritoneal fat, more or less abundant, is now exposed; if the patient is thin, the peritoneum will at once be seen, usually bulging, perhaps dark coloured owing to the under-lying blood; at other times the extra-peritoneal tissues may be thickened, infiltrated, ecchymosed, and, if care is not taken to separate them properly, so as to expose the underlying tense continuous peritoneal layer, one may easily be led astray. Lift up a small fold of the parietal peritoneum with the toothed dissecting forceps, make sure that it is quite empty (*Fig.* 246), and open it (*Fig.* 247): blood escapes. Now pass the left index finger into the opening, and on that finger complete

the division of the membrane upwards and downwards (*Fig.* 248) to the full extent of the superficial incision. Seize the two lips at once with two or three pairs of pressure-forceps on either side; or instead, as an alternative, suture the skin and peritoneal edges together: the threads should be left long, and will serve as retractors (*Fig.* 249).

The Abdomen is now Open.—Let the blood run away, cleanse the accessible area carefully with gauze swabs, without displacing or disturbing

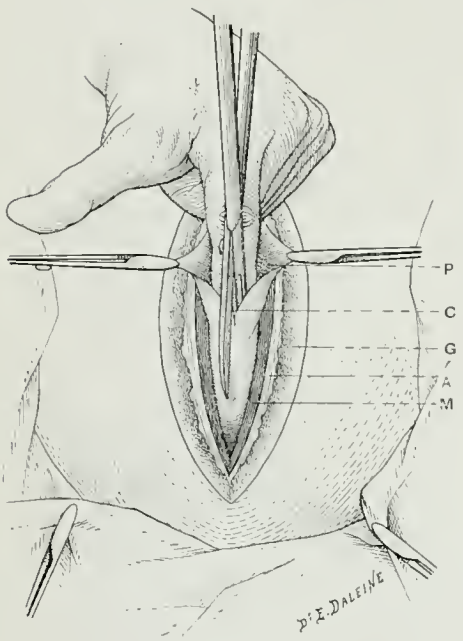

Fig. 248.—Infra-umbilical laparotomy. Section of the parietal peritoneum from above downwards on the finger. (P) Parietal peritoneum. (C) Scissors making the section from above downwards. (G) Subcutaneous fat. (A) Aponeurosis. (M) Rectus muscle.

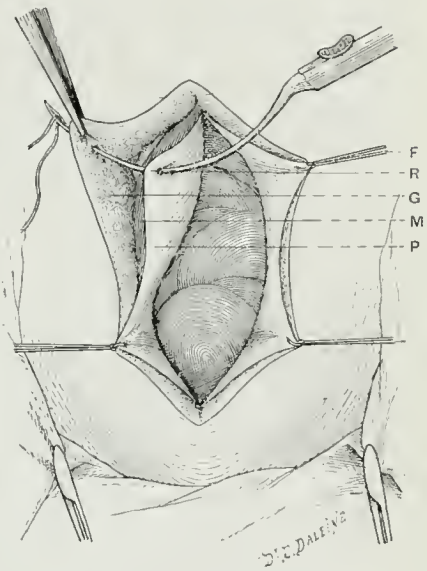

Fig. 249.—Infra-umbilical laparotomy. Suturing the parietal peritoneum to the skin. (F) One of the sutures serving as a tractor. (G) Subcutaneous fatty tissue. (M) Rectus muscle. (P) Parietal peritoneum. (R) Introducing one of the peritoneocutaneous sutures.

the coils of bowel which present themselves in the wound; survey the abdomen carefully, and explore it gently with the finger: this preliminary inspection always furnishes valuable information, sometimes indeed it allows of the discovery of the visceral lesions. This, however, cannot be counted on, and one must be prepared to undertake a careful search.

I presume that nothing but blood has been discovered, that the effusion has been considerable, and that the flow continues without cessation as fast as it can be sponged up. Do not hastily conclude that there is no perforation of the alimentary canal, but in order to find the source of the bleeding proceed to enlarge the wound. For this purpose cover up the intestines with a compress, carefully slipped under the edges of the incision, raise the abdominal wall by means of the left index-finger passed in at the

upper angle of the wound and applied directly to its deep surface; now with the scissors divide the skin and fat, afterwards the other tissues, layer by layer on the protecting finger, and secure the peritoneal edges with forceps as before. If it is necessary to prolong the incision downwards, bear in mind that the *bladder* is perhaps bruised and may appear as a blackish mass, and be easily mistaken for a large clot; the organ has several times been inadvertently opened simply owing to this misleading appearance.

It is difficult to say how long the abdominal incision may be made with advantage; if assistants are present who can take care that the intestine is kept well covered, the length is a matter of secondary importance, and a free incision, by facilitating the further stages of the work, saves much time, and therefore the patient's strength.

I.—THERE IS NO INTESTINAL PERFORATION.

Let us, however, suppose that *nothing but blood is found in the peritoneal cavity*, no intestinal contents, no bile, no urine.[1]

The source of the bleeding must now be sought for, and in order to do this with advantage, it will be well to first enumerate the possible sources.

(*a*). A tear of the **omentum.**

(*b*). A tear of the **mesentery** or one or other **mesocolon.**

(*c*). A tear of one of the other **peritoneal folds,** gastro-hepatic omentum, gastro-splenic omentum, etc.

(*d*). A rupture of a **large vessel,** splenic vein, renal vein, etc.

(*e*). A rupture of the **liver, spleen, pancreas, kidney.**[2]

(*f*). An **incomplete non-perforating rupture** of the intestine or stomach, or a perforation of such a character that no leakage has occurred.

(*g*). Lastly, a **combination of these various lesions,** in which case the prognosis becomes much more serious.

Intra-abdominal Exploration. — Before doing anything else, complete the sponging up of the effused blood, then proceed to make a careful inspection: if the **omentum** is not bleeding, raise it gently and turn it upwards; with finger and eye examine the exposed loops of bowel, draw them aside and inspect the mesentery. Having made sure that the blood does not proceed from thence, envelop the mass of intestines in a large compress, push it to the left side, and ascertain if the source of bleeding is not in the *depths of the flank*, from the mesocolon or the kidney, or higher up in the hepatic region; push the intestines to the other side, always keeping them carefully covered, and repeat the examination on the descending colon, the left kidney and the pancreatico-splenic region.

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[1] See later, Ruptures of the Biliary Tract, and also, Ruptures of the Bladder. The absence of intestinal contents does not prove that there is not a perforation, particularly when the opening is small and the operation undertaken at an early stage. This remark is peculiarly applicable to wounds caused by revolver bullets (see later).

[2] These ruptures are considered under their respective heads.

If the result of these investigations has been negative, if no blood is running from above downwards, but the hæmorrhage appears to originate in the true pelvis, then direct the search to that region. The inclined position is of the greatest assistance, and even in default of special appliances when operating with the patient on an improvised table, it can with some ingenuity be perfectly attained (see *Fig.* 250);[1] this position allows the mass of intestines, enveloped in a large compress, to be pushed up out of the pelvis above the sacral promontory, thus freely exposing the pelvic cavity to examination.

It is impossible to give more detailed description of the method of exploration, as naturally the procedure must be modified to suit the

Fig. 250.—Improvised Trendelenburg position.

particular case; the important point is never to search at random, but to work systematically, beginning with the area first exposed, and then to investigate the other regions in the order indicated.

Tears of the Omentum.—One may find the omentum: (1) **Crushed** over a more or less extensive area; (2) **Fissured,** more or less extensively; (3) **Separated** for a variable extent from its attachment to the great curvature of the stomach.

[1] In a case where, as is shown in the figure, only an ordinary kitchen table is available, some pillows, folded sheets, etc., are placed upon it under the loins and buttocks of the patient, while the pelvis is raised by an assistant who places himself between the patient's legs, with the knees resting on his shoulders.

Putting aside these para-gastric lacerations, in which torn gastro-epiploic vessels bleed profusely, the interstitial lesions of the omentum may give rise to *an oozing between the layers*, producing a hæmatoma of variable size, in which it is often exceedingly difficult to find the vessel which is bleeding. Therefore the omentum, when infiltrated with blood, should simply be resected in the manner presently to be described.

First of all draw it out of the abdomen, and place a large compress under it to protect and cover the intestines.

If there is **a localized area of injury,** dark coloured and thickened, secure its base with two or more chain ligatures, carefully tied (see STRANGULATED HERNIA, OMENTAL RESECTION), and then cut it away below the ligatures. It is quite useless to touch the bleeding surface with the thermo-cautery: much the better plan is to get hold of the larger vessels and apply direct ligatures to them.

If a large fissure is encountered which extends perhaps throughout the length of the omentum almost to the lower border of the stomach, spread the membrane well out, open up the fissure, remove the clots lying between the two margins, apply forceps, and then ligatures, to any vessels which are re-opened and begin to bleed when the torn surface is rubbed with a swab. Only the larger vessels need be thus secured: any oozing will be controlled by suture.

Bring the two edges of the fissure together by means of a continuous suture of catgut or silk, using a curved needle and fine thread; introduce first of all some *approximation sutures* passed at a distance of a quarter of an inch from the fissure and gently tied, and then the continuous suture, which should extend, above and below, a little beyond the extremities of the fissure.

When the omentum is **torn away from its attachment,** the associated lesion of the gastro-epiploic arteries generally gives rise to profuse bleeding, and naturally, in order to render it possible to deal efficiently with the injury, the abdominal wound must be sufficiently enlarged in an upward direction. It might be possible to draw down the great curvature of the stomach sufficiently to render the lesion accessible, but apart altogether from the fact that such a procedure is not always easy or indeed possible, it is always preferable when dealing with serious intra-abdominal hæmorrhage, **to operate with the affected organ lying in its natural position and not under traction.**

Therefore expose the great curvature and apply forceps below it to the two ends of the gastro-epiploic or whatever vessels are bleeding: usually direct ligatures may then be applied over the forceps. If any difficulty in doing so should be experienced, the vessel should be occluded at some distance from the laceration by a ligature passed around it. (See later, SERIOUS HÆMORRHAGES FROM ULCER OF THE STOMACH.) During this step, the omentum is held and compressed between the fingers of an assistant or in the fingers of one's own left hand, and it becomes a simple matter, once the torn edge of the omentum has been freed from clots, to

seize and ligature the principal vessels, and then to attach the separated membrane by means of a fine continuous suture to the great curvature; at least this has been done, and with success. However, to ourselves it seems better, if the separation is extensive, simply to remove the detached segment after preliminary ligature.

Tears of the Mesentery or a Mesocolon.—These are not at all uncommon, either as isolated injuries, or combined with other visceral lesions.

They occur in two forms: (1) **As fissures,** single or multiple, of varying lengths, and being the more serious the farther they extend towards the root of the mesentery and involve the large vessels; sometimes these injuries present the appearance of actual loss of tissue. (2) **As fissures**

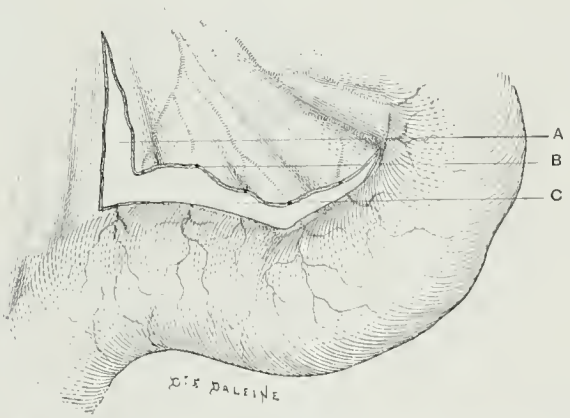

Fig. 251.—Mesentery torn and separated from its intestinal attachment. (A) Vertical slit. (B) Mesenteric vessels. (C) Separation of mesentery from intestine.

with separation of the mesentery from its attachment to a segment of the bowel (*Fig.* 251).

In one of our operation cases we found two extensive mesenteric fissures: one 5 ins. long extended right to the gut, and was not less than $2\frac{1}{2}$ ins. wide at the middle; the other was more than 8 ins. in length, and at the intestinal border was prolonged as a separation for about an inch. The margins of both fissures were carefully adjusted with continuous sutures of catgut; there were no other intra-abdominal lesions, and the patient recovered.

The treatment of these **mesenteric or mesocolic fissures** falls naturally into two stages: (*a*) The fissure being well exposed, the margins are cleansed with gauze swabs, and the bleeding vessels are seized and tied with fine ligatures; (*b*) The two edges are brought together by a continuous suture, or better, by a series of interrupted sutures (*Fig.* 252).

The sutures should be introduced at a distance of about a quarter of an

inch from the margin of the fissure, and great care must be exercised that they are only passed in *definitely avascular spaces;* if one should happen to puncture a vessel a hæmorrhagic infiltration will be seen, a hæmatoma between the two layers of the membrane, springing up under one's eyes—a condition it is often difficult to deal with directly: the best plan in such a case is to occlude the vessel by means of a ligature passed around it through the mesentery proximal to the wounded point. But it is necessary to exercise caution in interfering with the mesenteric vessels, lest the blood supply to the intestine be unduly impaired.

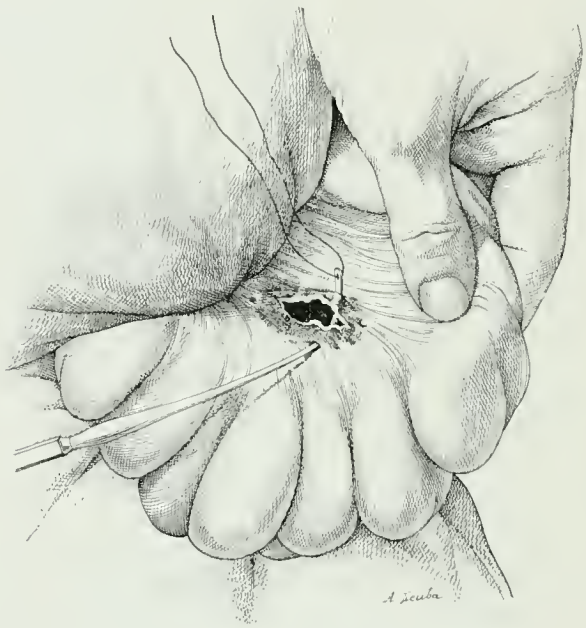

Fig. 252.—Closing a mesenteric tear with interrupted sutures.

If the fissure is comparatively short and the margins well defined, a plan recommended by Moynihan may sometimes be adopted: the corresponding vascular orifices on the two lips are caught with fine pressure-forceps and a common ligature is applied over each pair, thus at one time occluding the two bleeding points and approximating the opposed margins (*Fig.* 253).

The risk of intestinal gangrene is very serious in cases of **extensive mesenteric separation**, or loss of tissue in the vicinity of the gut, or when the great mesenteric vessels are involved in wounds or fissures. Instances are numerous.

Case 19.—A man aged 64 years had stabbed himself in the left side of the abdomen; profuse bleeding occurred, and the bowel protruded from the wound; laparotomy was performed, and it was found that the mesentery alone

was injured; the bleeding mesenteric vessels were tied, and the fissure in the membrane was sutured; the patient died in forty-eight hours. At the autopsy the intestinal segments corresponding to the wounded and ligated mesenteric vessels were found to be either already or in process of becoming gangrenous.[1]

Case 20.—A man fell on his abdomen and lost consciousness, but quickly recovered and felt well enough to go to dinner in town. Shortly afterwards, however, very serious abdominal symptoms appeared. Laparotomy was undertaken twenty-four hours after the accident, and a large portion of the gut was found to be gangrenous; death ensued some hours later. The autopsy disclosed a laceration of the mesentery involving a large branch of the superior mesenteric artery.[2]

As a practical conclusion, it may be said that when the gut is stripped of its mesentery over a considerable segment, exceeding four inches, immediate resection of the loop ought to be performed, as necrosis is almost certain to

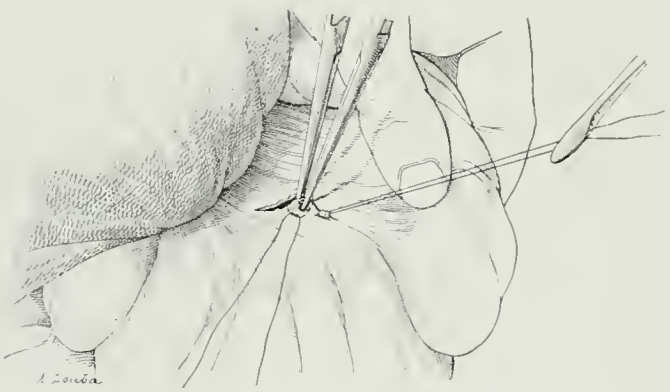

Fig. 253.—Closing a mesenteric fissure by ligatures grasping corresponding vessels in the two edges.

occur. If the separation is very short and the appearance of the gut absolutely normal, then reattachment of the mesentery may be tried, either by suturing it to the fringe which is usually left hanging to the intestine, or by suturing it to the serous coat of the bowel. In any case the corresponding loop of bowel ought to be considered as under suspicion, and care be taken to fix it near to the parietal wound.

Tears of the various Peritoneal Folds.—In these cases there are always two things to be done: (1) *To seize and tie the vessels in the margin of the tear*: (2) *To restore the peritoneal ligament* as far as possible by suturing

[1] Lockwood: *Medical Society of London*, 14th May, 1897.

[2] Howard Marsh: *Medical Society of London*, 14th May, 1897. Michaux has recorded the case of a carter, aged 33, who fell from his cart, one of the wheels of which passed over his abdomen. Laparotomy was performed twenty-three hours after the accident, and a loop of the ileum, about ten inches long, situated six inches from the cæcum, was found to be completely separated from the mesentery; the loop was absolutely flaccid and of a greenish-bronze colour. The loop was resected and the two ends were sutured in the lower angle of the wound. Death occurred two days later. (Michaux, *Bull. de la Soc. de chir.*, 1895.)

the two margins of the fissure : the latter point is very important because it is necessary to re-establish the continuity of the membrane in order to prevent the formation of abnormal orifices, bands, adhesions, and all the other factors which may ultimately cause secondary intestinal obstruction.[1]

Ruptures of the Large Vessels of the Posterior Abdominal Wall.—It is out of the question to discuss here the injuries of the great pre-vertebral vessels—the aorta and its branches, or the vena cava—ruptures of which are usually so speedily fatal as not to allow time even to think of operative intervention.

In the cases of which we are speaking, it is most often the **splenic, renal,** or **mesenteric veins** which are involved. Almost invariably there is great extravasation of blood, situated deeply, and made evident only after the mass of intestines has been laterally retracted ; there is blood in the peritoneal cavity, between the layers of the mesentery and the meso-colon, and under the posterior peritoneum ; the blood covers everything, masks everything, and if any hasty endeavour is made to apply forceps to the supposed bleeding points, a very considerable risk will be incurred, not only of failing to check the hæmorrhage, but of wounding some important structure.

Make a large tampon with one or two aseptic compresses : apply this to the point whence the blood comes, and press firmly ; quickly wipe away the blood and remove the clots which obscure the field. Now raise the edges of the tampon little by little, sponging as the work proceeds ; finally the bleeding vessel or vessels will be seen, and the bleeding points may be seized with forceps. The task, however, requires a good deal of coolness and deliberation.

Great caution is required in ligating the vessels which are caught in the jaws of the forceps ; the walls of these abdominal vessels, particularly the large veins, are very friable and tear readily under the constriction of the thread : should such a misfortune occur, the whole thing must be begun again, and under much more dangerous conditions. The endeavour may be made to tie them, using a pliable ligature, tightened very slowly and gently ; but if the attempt appears to be too difficult, it is better simply to **leave the forceps in position,** and remove them with great care at the end of forty-eight hours.

In one case I myself was compelled to leave five pairs of pressure-forceps in position in a wound of the splenic vein : the blood ran in a copious stream ; by using a large tampon in the manner already described, I was enabled to discover the bleeding vessel ; several pairs of forceps failed to hold, but finally I succeeded in checking the bleeding completely. The forceps were surrounded by a fold of aseptic gauze, and when removed on the third day there was no recurrence of the bleeding.

[1] Owing to the friability of the peritoneal folds, these measures cannot always be completely carried out, and firm packing is comparatively often the sole available resource, as in a case recorded by M. Paul Delbet, where the bleeding came from a tear in the lesser omentum. "Contusion de l'abdomen, hémorragie par déchirure indirecte du petit épiploon." *Gaz. des hôp.*, 27 février, 1902).

In these cases, after the main sources of hæmorrhage have been secured, it is advisable to pack with gauze down to the damaged area, for the vascular lesion is always associated with more or less injury to the adjoining tissues, and this may give rise to a considerable amount of oozing.

Finally, **gauze packing** remains as a last resource in the cases where nothing can be ligated or controlled by forceps pressure; but if it is to be of any use, the gauze must be carried right down to the bleeding focus, and must be packed firmly enough to exercise real mechanical pressure. Otherwise it is absolutely useless, and serves merely to plug the external wound while allowing the hæmorrhage to continue unchecked into the peritoneal cavity.

Ruptures of the Liver, Spleen, and Pancreas.—*Hæmostatic suture*, *continued forceps pressure*, and *gauze packing* are the various available methods of dealing with these conditions. Once the lesion is discovered, the technique is the same as for wounds, which we shall study in a subsequent paragraph.

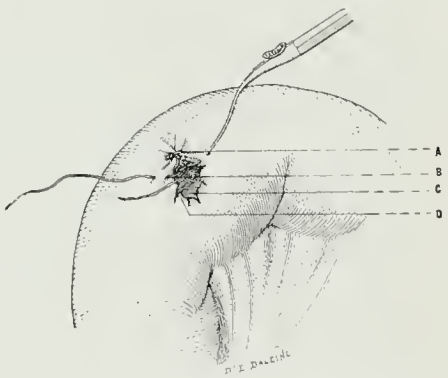

Fig. 254.—Non-perforating laceration of the intestine. Suturing the torn external coats. (A) First Lembert suture. (B) Second suture bringing together the serous surfaces on either side of the lesion. (C) Base of the laceration. (D) Irregular margin of the laceration.

Non-perforating Ruptures of the Stomach and Intestine.—As a matter of fact, the intestine is the most frequent source of the hæmorrhage, and the intestinal wall bleeds very freely even when the injury does not implicate its whole thickness.

These **incomplete, non-perforating ruptures** occur in the form of (1) **Fissures** of variable length and direction affecting the serous coat alone or the seromuscular layer; (2) **Gaping lacerations** with stripped up, everted margins, produced by a bursting action.[1]

Draw the loop outside the abdomen and place it on a gauze compress; cleanse the fissure and open it up gently, so that its full extent may be determined, and it may be possible to clean the whole track; then close

[1] A rupture produced by crushing may be observed, involving the mucous and muscular layers, while leaving the serous coat intact; such a feeble barrier may very readily give way during the days immediately following the injury. The cases, primarily benign, in which delayed and fatal general peritonitis suddenly develops, probably belong to the group of incomplete ruptures. (Fevrier, *Arch. prov. de chir.*, 1896.) It is always well when these subserous ruptures are discovered to bury them by means of continuous Lembert sutures. Non-perforating lesions such as these are often multiple; in one of Février's patients, who had been kicked by a horse in the right iliac region, the infiltrated and discoloured cæcum was the seat of three incomplete ruptures: one by crushing and two by bursting. With regard to the stomach, Rehn has studied the different varieties of lesions of the mucosa produced by contusion (fissures, separation by interstitial hæmatoma, stripping up of a large flap); and the symptoms, (immediate) hæmatemesis, sometimes very profuse, and (late) ulcers which result. (Die Verletzungen des Magens durch stumpfe Gewalt. *Arch. fur klin. Chir.*, 1896, liii., 2, p. 383.)

it by means of a continuous suture or, as shown in *Fig.* 254, by a series of interrupted sutures, which will at the same time check any bleeding.

If one has to deal with a larger gaping laceration, or with a partially detached flap of the seromuscular coat exposing the mucous lining, let the flap be re-applied after having carefully cleansed and dried its deep surface, and suture it in position, thus closing the breach. If its border is bruised and torn and seems likely to necrose, it must be excised, after which the gap will be covered in by bringing the margins together with a continuous or interrupted Lembert suture (see later), the mucosa which forms the floor being thus thrown into a fold projecting into the interior of the gut.

When effused blood has been found in the peritoneal cavity, and when one of the various lacerations which we have just described has been discovered and dealt with, the parietal wound must never be closed before the focus of injury and the pelvis, which always contains a considerable quantity of blood, have been carefully and thoroughly cleansed by means of gauze swabs; further, **before closing the abdomen make sure that all oozing has ceased**; if any persists, even though the amount should be very small, it will be advisable either to pack the bleeding area or to leave a drainage tube in the pelvis.

Lastly, one must never forget that the sources of hæmorrhage are often *multiple* and some of them may easily be overlooked, and that the operator may, while thinking that the conditions have been well and thoroughly treated, leave undetected a visceral lesion which will later give rise to a fatal secondary hæmorrhage. The following is a striking example :—

Case 21.—A workman, aged 24, had received a violent blow on the chest and abdomen in a lift accident. During the first two days after the accident he complained of diffuse thoracic and abdominal pains. The pulse was good, the face in no way changed, and there was no abdominal distention, but on palpation the muscles of the abdominal wall contracted strongly. This muscular rigidity became more and more marked, and at the same time a moderate degree of distention developed. Chiefly because of these two signs, the significance of which we have already discussed, and also because of the general condition, on the third day we opened the abdomen. We found about three pints of blood in the peritoneal cavity, and after a minute examination discovered only a tear of the great omentum, which was closed, and the bleeding arrested by means of a continuous suture of catgut. The peritoneum was irrigated with warm boiled water to remove the clots, and gauze packing was left in the right flank, where some oozing still persisted. All went well for the first ten days, and with the aid of subcutaneous infusions of saline solution the general condition had improved and recovery seemed almost certain, when on the eleventh day death occurred suddenly, in a few moments. At the autopsy we found the abdomen full of blood and *a large laceration in the posterior border of the liver*, from which the secondary fulminating hæmorrhage had proceeded.

II.—PERFORATIONS AND RUPTURES OF THE INTESTINE.

In this second hypothesis, the situation is a serious one in another way, because of the resulting peritoneal infection.

Perforations and ruptures may affect the small or the large intestine or the stomach.[1]

Generally the state of affairs is recognized as soon as the abdomen is opened: intestinal contents and gas escape along with the blood. Sometimes, however, at first only blood and clots will be seen, and it will not be until a little later, when raising the omentum or separating the coils of intestine, that the extravasated bowel contents will become evident. The *character of the extravasated matter* may give some indication of the seat of the lesion; the stomach contents, in which recognizable particles of foodstuff are always present, can be distinguished from the yellowish liquid coming from the small gut, or from the brownish and denser material from the large intestine

The Search for the Perforation.—Here, even more perhaps than in the case of abdominal hæmorrhage, it is of the utmost importance to avoid displacement of the intra-abdominal viscera, and to make the investigation as far as possible with the organs in their natural position.

If a sub-umbilical injury is being dealt with, as soon as the abdomen is opened, slip a fold of gauze into the cavity at the upper angle of the wound; the gauze, together with the omentum, will form a barrier to protect the upper abdominal zone; do the same at the lower angle if the incision has been made above the umbilicus; though in the latter case the diffusion of the effused fluids is always more considerable than in the former, and it will often be necessary afterwards to prolong the incision downwards in order that the pelvis may be thoroughly cleaned.

Then sponge up the blood and intestinal fluid, and endeavour to locate the lesion by following the track of the extravasated fluids, gently separating the intestinal loops; when the blow has fallen full on the abdomen, as for instance when the patient has been kicked by a horse, always direct the investigation towards the neighbourhood of the vertebral column.

This primary exploration, carefully conducted, and without precipitation, will often disclose the intestinal injury. The lesion may

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[1] According to Rehn, complete ruptures of the stomach are usually fatal in a very short time, often in a few hours; early operation is therefore of extreme importance. He gives an excellent example of the results which may be obtained by operation. A young girl, aged 19, had just hurt herself by falling against the rail of a balcony: the left hypochondrium and the epigastrium were the regions injured. There was temporary loss of consciousness, intense pain in the injured area, rigidity of the abdominal wall, vomiting of blackish material, and dullness in the left hypochondrium which extended steadily forwards and to the right. A diagnosis of rupture of the stomach was made, and the abdomen was opened about five hours after the accident. The stomach was found retracted, and was drawn outside the abdomen: on its anterior surface there were two fissures as definite as if made with a knife, one about an inch long involving only the serous coat; the other, three inches in length, seromuscular. Some blood-stained fluid mixed with mucus and particles of food continued to flow from the depths of the peritoneal cavity, through a hole in the great omentum close to its attachment to the stomach; the opening was enlarged and then a complete rupture of the posterior wall of the stomach, placed vertically and about four inches long, was discovered. The rupture was closed by a double row of sutures. Bleeding still persisted, and further investigation showed that the lower extremity of the spleen was bruised and its capsule torn in front for a length of nearly two inches; the torn capsule was sutured, a bleeding vessel at the hilum was ligated, and the region packed. After careful cleansing of the peritoneum, the abdominal incision, which it had been found necessary to extend to either side in the fashion of a cross, to facilitate the exploration, was sutured. Recovery. (*Loc. cit.*, p. 392.)

appear in varied forms, which will be studied presently, from a complete rupture to a small rounded opening, bordered by everted mucous membrane, from which a little yellowish fluid is escaping; however that may be, seize the damaged loop between the fingers and compress it on either side of the perforation, draw it out of the abdomen, and place it on a compress (*Fig.* 255); then see at once if there is not another perforation in one of the neighbouring loops in the same area. As a matter of fact, multiple lesions are very common,[1] and they usually occur in adjacent loops situated in the injured region, although they may be separated by a considerable distance measured along the line of the bowel. By proceeding at once to deal with

Fig. 255.—Ruptured loop of bowel drawn outside the abdomen and isolated by gauze compresses; the two ends of the loop are held and compressed between the fingers of an assistant.

the first found lesion, without completing the preliminary examination, a considerable risk of spreading the extravasation will be incurred, and also of complicating and unnecessarily prolonging the further steps of the operation.

When the exploration *in situ* has given no positive result, and the lesion has not been discovered, then the intestine must be methodically examined —in other words, must be followed through its whole length, **starting from a definite point** and working **in a definite direction.** The latter point

[1] In the cases of intestinal rupture caused by horse kicks, a *triple perforation* of the affected loop has frequently been observed. The mechanism of the injury has been elucidated by M. Moty: there is a median perforation, large and oval, with its chief axis parallel to the line of the gut, and two smaller perforations about two or three inches apart. In such a case, the loop has been caught between the horse-shoe and the resistant surface of the vertebral column; the two small lateral tears correspond to the margins of the shoe and the central laceration has been caused by bursting. (Moty, *Revue de chir.*, 1890.)

is of primary importance, as a search for a lesion by following the line of the gut without a definite method is confusing, misleading, and dangerous. If the **cæcum** presents itself at once, or if it is easily found by retracting the right margin of the wound and displacing a few coils of small intestine, it will be taken as the *starting point*, the terminal part of the ileum will be sought for on its inner aspect, and then the small gut will be passed through the fingers from below upwards. On the other hand, if there is any difficulty in getting hold of the cæcum, lose no time in looking for it, but take one of the loops presenting in the wound as a point of departure, have it held by an assistant, or pass a thread through the mesentery to serve as a landmark, and then proceed to make the necessary examination first in one, then in the other direction.

The search must be made without undue exposure of the abdominal contents: large compresses must be spread out to cover and retain the mass of intestines above, below, and on either side of the wound, and into the centre of the area so surrounded successive segments of gut, two or three inches in length, will be drawn and examined, the two hands of the operator working methodically together, the thumbs on one aspect of the gut, the fingers on the other, bringing the bowel from under cover on the left side and passing it under the protecting compress on the right.

The damaged segment usually presents a reddish, infiltrated, ecchymosed appearance: often also the loop is contracted and collapsed, sometimes to a considerable distance above and below the point of perforation: such an appearance should always arouse suspicion, and the examination ought to be pursued with increased caution to avoid causing a discharge of intestinal contents.

Once a perforation or rupture is discovered, the injured loop will be retained outside of the abdomen, protected by compresses, until the work of inspection is completed. Before undertaking any reparative measures, it will be well to make the search in the manner already detailed, and to place all the damaged loops—if there are multiple perforations—outside the abdomen, the rest of the operation will then be completed more quickly and more surely.

Fig. 256.
Intestinal needles.
Hagedorn's needles.

Although abdominal distention in delayed operations often causes serious difficulties, this systematic examination, when quietly and methodically conducted, gives excellent results, and in the ordinary conditions of urgent surgery is much less dangerous than *total evisceration*, of which we shall speak later on. (See Intestinal Obstruction.)

The Closure of the Perforation.—As soon as the lesion is discovered it must be closed, and the technique must be adapted to the different types of gastro-intestinal injuries which we are about to consider.

Let us first lay down the general principle that all suturing ought to be executed *outside the abdomen*, the loop being withdrawn sufficiently, and surrounded by gauze compresses (*Fig.* 255).

The success of an intestinal suture to a great extent depends on the method adopted; the general rule may be expressed in the following words:

Fig. 257.—Reverdin's intestinal needles, straight and curved.

a good suture must be **watertight** and must **approximate an adequate extent of the serous surfaces.**

The choice of needle and thread is of importance: preference should be given to fine silk as the suturing material, because of its pliability, strength, and easy sterilization. Reverdin's intestinal needles (*Fig.* 257), curved or straight, may be employed, or fine curved needles (*Fig.* 256) in a needleholder, or held with a pair of pressure-forceps, or again, simply long fine needles (*Fig.* 258) held in the fingers.[1]

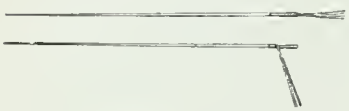


Fig. 258.—Straight intestinal needles with lateral spring eye.

We shall here include in our consideration the intestinal lesions caused both by wounds and sharp instruments.

1. A Small Circular Perforation.

A small circular opening has been discovered, bordered by everted mucous membrane, with more or less bruising around it.

If quite small, close it by means of a **purse-string suture.** First wipe the protruding mucous margin with a small swab moistened with alcohol or a 10 per cent solution of chloride of zinc; if necessary, pouting mucous margins may be excised with curved scissors; a little bleeding will result, but it is of no importance, and will be readily checked by the suturing: pass a silk thread in and out around the perforation at a distance of about one-sixth of an inch from the margin, picking up the whole thickness of the sero-muscular coats (*Fig.* 259): now draw the two ends of the suture together, at the same time depressing the centre of the orifice with a director until it is buried. When the approximation is complete and the serous surfaces in satisfactory contact, finish off the suture with a double knot. If the perforation is larger, if the wall of the bowel is thickened, or

[1] The simpler the instruments the better; with some practice an ordinary sewing needle, held and used with the fingers, serves excellently. Here, as in all other manual work, training plays an important part.

there is the slightest difficulty in burying the central portion, it will be a wise practice to apply two or three interrupted Lembert sutures over the purse-string. (See later and *Fig.* 260.)

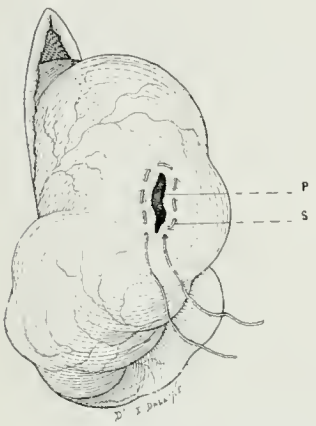


Fig. 259.—Small perforation. Purse-string suture. (P) Perforation. (S) Suture thread passed in and out through the tissues surrounding the perforation.

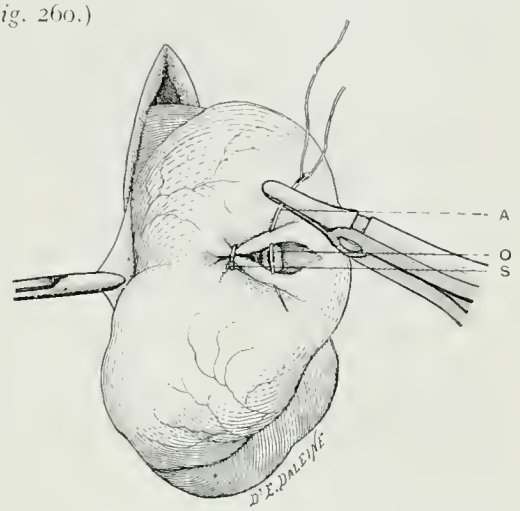


Fig. 260.—Small perforation. Purse-string suture. Burying the purse-string by a few interrupted Lembert sutures. (A) Needle passing one of the interrupted sutures. (O) Circumference of the perforation gathered in by the purse-string suture. (S) First interrupted suture.

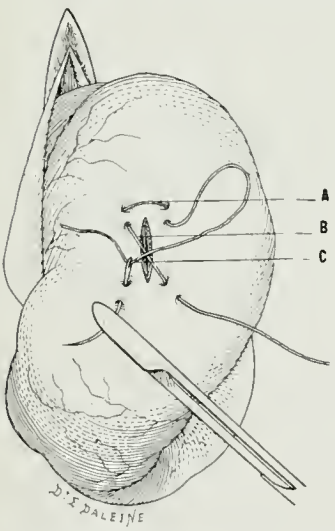


Fig. 261. — Double-crossed Lembert suture; passing the thread. (A) Loop placed a little beyond one extremity of the wound. (B) One of the ends crossing the wound obliquely. (C) The other end crossing the first obliquely, and picking up the seromuscular coat of the bowel.

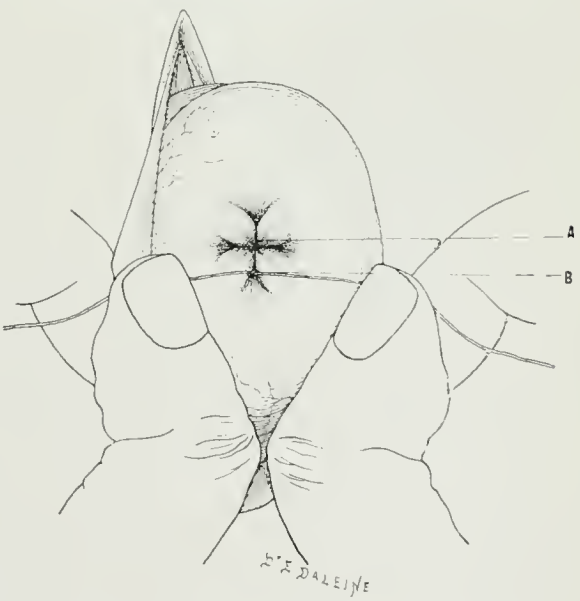


Fig. 262.—Double-crossed Lembert suture: the thread has been tied. (A) Puckering of the lips of the wound, which are brought together by their serous surfaces. (B) Terminal knot.

The **double crossed Lembert suture** described by Juvara of Bucharest is another method of obtaining perfect occlusion; *Figs.* 261 and 262 render description unnecessary.

Neither of these methods is satisfactory when dealing with a large perforation, having the dimensions of say a shilling or two-shilling piece; after having freshened the margins and transformed the rounded opening into a lozenge-shaped or elliptical slit, it will be closed in the manner we are about to describe. (See WOUNDS.)

We shall also subsequently refer to the treatment of multiple closely situated perforations, rendering the injured segment *quite irreparable* and necessitating resection.

2. Wounds and Partial Ruptures.

Let us assume first of all that we have to do with a transverse wound with clean cut, bleeding, and healthy margins. These *incised wounds* are sometimes met with after rupture by contusion as well as after injuries caused by sharp instruments; if produced by contusion, and the margins are bruised, discoloured and of doubtful appearance, naturally the first step will be to freshen them with the scalpel or the curved scissors.

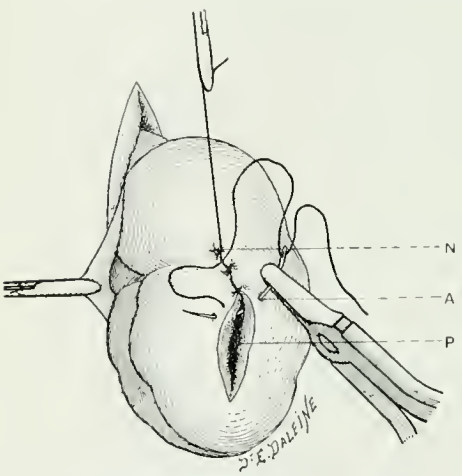


Fig. 263.—Suturing a wound of the intestine. Inner continuous suture, including all coats. (N) First turn of the suture. (A) Needle passing through the whole thickness of the wall. (P) Edges of the wound in the intestine.

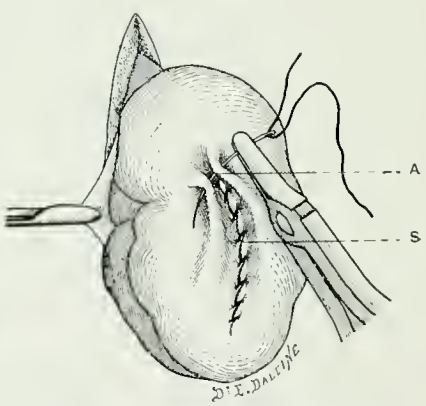


Fig. 264.—Suturing a wound in the intestine. First turn of the outer serous suture beginning a little way beyond the extremity of the wound. (A) Needle passing through the two seromuscular folds which are about to be brought together. (S) Inner suture.

This condition is a simple and typical one, in which healing ought to be obtained without difficulty.

First apply a continuous suture, taking up the whole thickness of the wall of the bowel: pick up and fix one of the lips with toothed dissecting forceps, pass the needle through it close to the margin from without inwards, then through the oposite lip from within outwards; draw the suture through, and knot it. Continue the suture as in *Fig.* 263, drawing it moderately tight at each turn until the other end of the wound is reached, when it will be finished off in the manner depicted in *Fig.* 266.

The next step is to introduce a suture approximating the serous surfaces, the **sero-serous suture.** A fold must be raised on each of the margins of the wound, the serous surfaces of these folds must be brought together, and the larger the surfaces so applied one to the other, the more certain will union be. An intestinal suture does not consist in uniting the different tunics, edge to edge ; it consists essentially in a *wide and close application of the serous coats* on either side of the wound. That is the fundamental principle of Lembert's suture and all its modifications : it allows of no exception, because it is based on the physiological laws of the peritoneum.

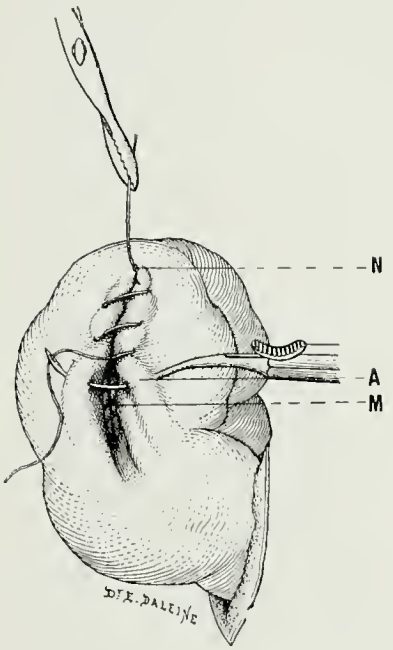


Fig. 265.—Suturing a wound in the intestine. Continuation of the outer serous suture. (N) First turn of the suture : one of the ends of the thread secured by forceps. (A) Seromuscular fold being traversed by the needle. (M) Inner suture.

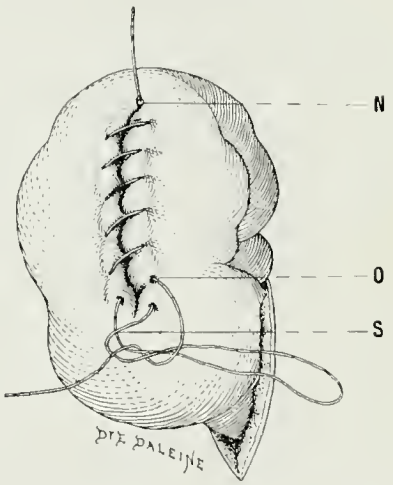


Fig. 266.—Suturing a wound in the intestine. Completion of the outer serous suture ; the terminal knot. (N) First turn of the suture. (O) Free end of the thread. (S) Loop which is being used in the formation of the terminal knot.

Begin the sero-serous suture an eighth of an inch beyond one of the extremities of the wound, the infolding of the two edges will thus be rendered more easy ; introduce the needle at a distance of about a third of an inch from the right border, so that it passes well into the muscular coat and, after underrunning a bridge of tissue a sixth of an inch wide, emerges about a twelfth of an inch from the margin ; it is then made to penetrate the tissues on the left side of the wound in the same manner but in a reverse direction, finally emerging at a point symmetrical with the point of entry (*Fig.* 264).

Continue the suture, placing the loops regularly at distances of about an eighth of an inch, and exercising sufficient traction on the thread to bring and keep the opposed surfaces in close contact all along the line (*Fig.* 265). Be careful to lock the suture at every third or fourth turn in the way shown

in *Fig. 267*; but before completing it and tying the terminal knot, apply a gentle final traction and make sure that the two serous folds are properly adjusted (*Fig. 266*). When applied in this way the continuous is the best form of suture, and meets all requirements; if at any point the line of union appears a little slack, or if the wall, being somewhat friable, has been cut by the thread, an interrupted security suture can be applied.

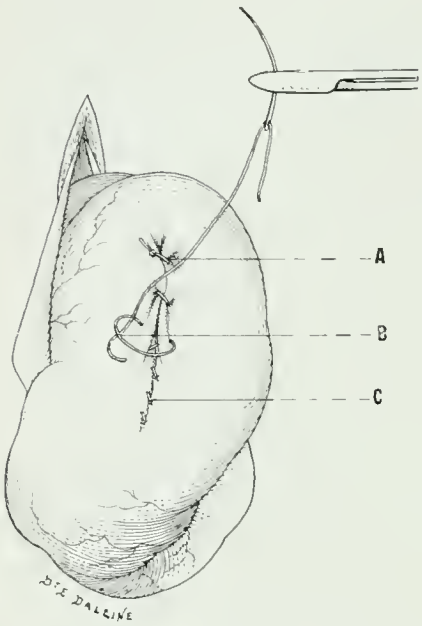


Fig. 267.—Suturing a lateral wound of the intestine. Outer serous suture; method of locking the suture at every third or fourth stitch. (A) First turn of the suture. (B) A locking point. (C) Inner suture, including all coats.

The situation of the transverse wound may necessitate certain modifications of the method just described, or particular attention to certain technical details.

1. **The Wound implicates the Mesenteric Border.**— This is the situation where suture is always the most difficult, and where it most often fails.

Do not commence by suturing the tear in the mesentery, but rather enlarge it longitudinally with the finger or some blunt instrument, and retract the two borders so as to get a good view of the retro-mesenteric part of the intestinal injury; *introduce the first turns of the suture at that point* at the posterior extremity of the wound, and continue it from behind towards the free border of the bowel. At the mesenteric attachment the suture, in addition to picking up the seromuscular coat of the bowel, will also be passed through the mesentery on either side, so bringing the margins of the slit together (*Fig. 268*): once the intestinal wound is satisfactorily sutured, the rest of the mesenteric fissure can be rapidly closed by means of a continuous suture. The greatest care must be devoted to the loop of the suture *at the mesenteric border*, and it will always be advisable to reinforce the continuous suture there by two or three interrupted points.

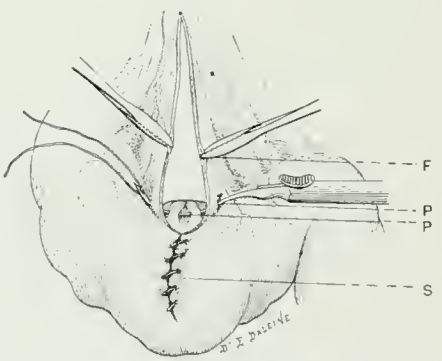


Fig. 268.—Wound involving the mesenteric border. (F) Margin of the mesenteric slit. (PP') Introducing the suture at the mesenteric attachment; the needle picks up both edges of the mesentery and two small folds of the seromuscular coats on either side of the wound. (S) Inner suture.

2. **The Wound affects the Free Border and involves more than half the circumference of the Bowel.**—In this case it is rather difficult to bring the edges together regularly without puckering; the retracted and flaccid wall of the intestine is ill-adapted for easy suturing; and further, owing to the extent of the wound, a considerable diminution of the calibre of the canal is to be feared.

First pass a loop through each of the ends at the anti-mesenteric border, including the serous and muscular coats, but without perforating the mucous membrane: these two *guiding threads* will serve as landmarks and facilitate the regular application of the double continuous suture by enabling the intestinal wall to be fixed and stretched (*Fig.* 269). Introduce the first continuous suture, picking up the entire thickness of the wall, but being careful to include no more of the tissues on either side of the wound than are sufficient to give a secure hold to the thread; also see that the loops are properly and regularly spaced, and that there is no protrusion of mucous membrane between them; then bury the first suture line by means of a second continuous sero-serous suture.

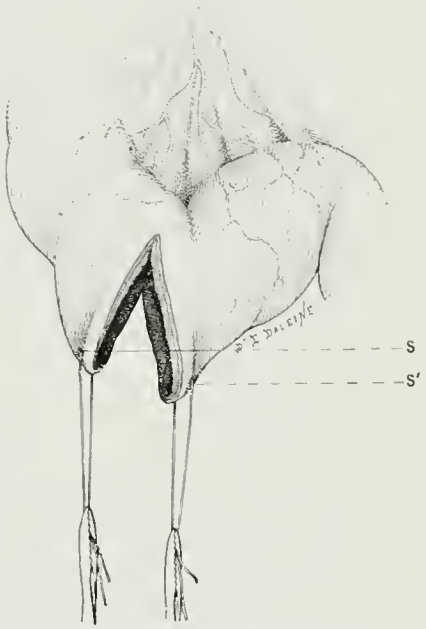


Fig. 269.—Wound of the free border involving more than half the circumference of the intestine. Fixation of the edges of the wound by two sutures. (SS') The sutures passed in the seromuscular coats at the free border and secured by two forceps.

3. **There is a considerable Deficiency in the Wall of the Intestine.**—Naturally the situation is very different in cases where it has been necessary to excise a considerable portion of the wall (*Fig.* 270) in a longitudinal or very oblique direction: the infolding of the lips of the wound aggravates in some degree the loss of tissue, and the intestinal tube may be considerably narrowed, or so distorted that a spur or acute angulation results.

To follow the ordinary method of suturing under such circumstances would be to court a serious risk both of failing to obtain union and of causing intestinal obstruction, either immediately or at a later date.

Should the deficiency be great, and the wall destroyed to the extent of say half its circumference, then **resection, followed by end-to-end enterorrhaphy or lateral anastomosis**, becomes the method of choice, and is decidedly the safest practice. When the loss of tissue is less, the condition may often be treated very satisfactorily by the following method:—

Excise the damaged borders of the wound in such a manner as to

form a **lozenge-shaped opening** (*Fig. 271*), *then suture together the two pairs of borders which face in the direction of the long axis of the bowel.*

Some amount of traction is required, at least at the middle part of the gap, to bring the edges in contact, the suture must therefore take a good

Fig. 270.—Large and irregular wound of the intestine: considerable loss of tissue is unavoidable in trimming the edges.

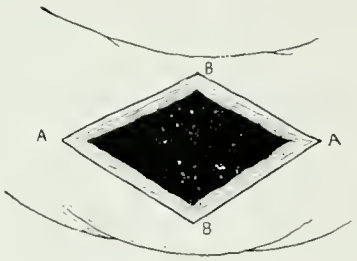


Fig. 271.—The lacerated edges excised so as to form a lozenge-shaped opening. After being sutured the points AA will be in contact; the points BB will form the extremities of the suture line.

hold of the tissues on either side. First introduce a continuous suture approximating the opposed margins (*Fig. 272*), beginning at the upper angle and picking up a good thickness of tissue on either side; tighten each loop carefully, and keep steady tension on the thread while the needle is being passed through the tissues, so as to prevent relaxation of the suture and separation of the wound edges; and do not neglect to lock the suture at frequent intervals. The suturing will be continued in this manner until the centre portion of the gap, the position of greatest separation, is reached. For the sake of additional security it is a good plan to apply the continuous suture in two parts: work first from the upper angle to the mid point, then knot the thread and secure the end with a pair of pressure-forceps: then begin the second half of the suture at the inferior angle, and work toward the mid point, finishing by knotting the end of the second to that of the first: in this manner tension will be more evenly distributed and the liability of the thread

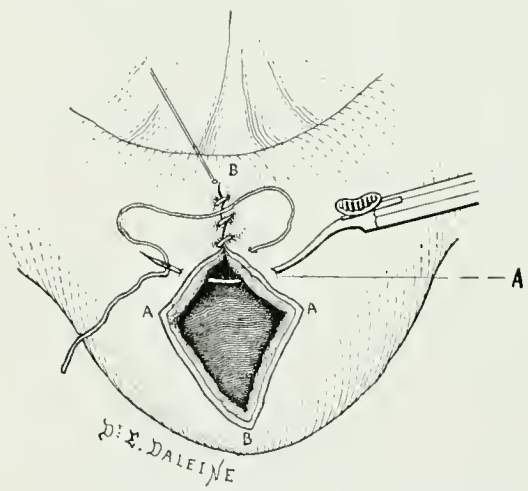


Fig. 272.—Suturing the edges of the lozenge-shaped gap. When the suture is completed the points AA will be united, and the points BB will form the extremities of the suture line. (A) The needle passing the inner continuous suture, including all the coats.

cutting out at the centre of the line of suture will be considerably diminished. A continuous supporting sero-serous suture will be applied over the first (*Fig.* 273).

This method of repairing a deficiency is naturally attended by some degree of incurvation of the intestine: this must not, however, go so far as to form an angle. When the gap is situated on the anterior or posterior aspect of the gut, acute angulation is less to be feared than when the wound is on the free border, because in the latter case there is a tendency for the distortion to be exaggerated by the traction of the mesentery.

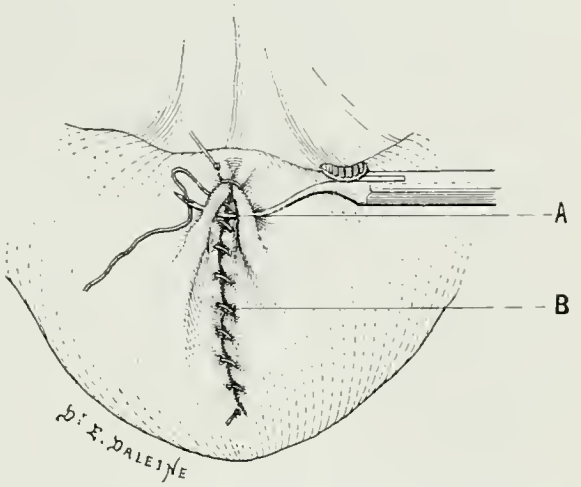


Fig. 273.—The lozenge-shaped gap is closed; note the appearance of the sutured loop. (A) Outer serous suture. (B) Inner suture.

To resume: the continuous suture constitutes the simplest, most rapid, and safest form of suture for all wounds of the intestine, and every medical practitioner ought to make a point of learning how to execute it properly.

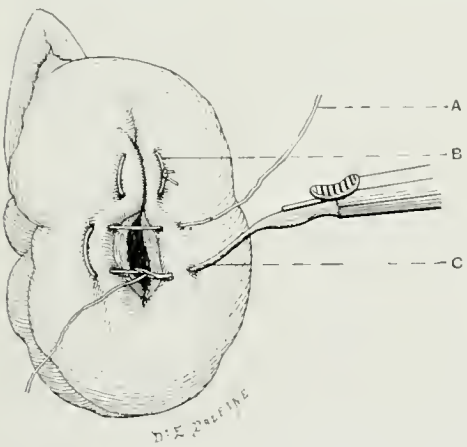


Fig. 274.—Closing a wound of intestine by a series of mattress sutures. (B) First suture, finished. (A) One of the ends of the second suture. (C) Needle drawing through the other end.

The *interrupted suture* is less generally applicable, although on the whole, if the points of suture are placed close enough, it gives very good results and assures regular adjustment of the edges of the wound; still, as each suture is exerting its traction at right angles to the line of the wound, and must also be tightened and knotted separately, it is very apt to cut or tear the wall of the bowel, particularly when this is in an infiltrated or friable condition, a very common state of affairs in cases of intestinal rupture.

When the intestinal wall is very friable, the **mattress suture**, represented in figure 274, is sometimes very useful, for the reason that it is much less apt to cut out, and gives a better hold on the tissues

for turning in the edges of the wound. It consists essentially of *a series of* U *loops placed across the line of the wound*, which, as they exert their traction when tightened at right angles to the surface of the wall of the bowel, brings the opposed surfaces smoothly together. It is very easily executed, but it requires a little more time than the continuous suture.

U-*shaped loops placed parallel* to the wound produce a quite different result, and have different applications: they pucker up the tissues in their grasp, and act in fact like so many purse-string sutures placed along the line of union.

Before speaking of circular enterorrhaphy, I wish to mention two plans which may be of use in certain exceptional cases where the number of the lesions and the necessity for speedily terminating an operation compel the surgeon to do what he can rather than what he would wish to do: I refer to **intestinal grafting** and **entero-anastomosis.**

Intestinal grafting consists in occluding the perforation by applying to it the wall of a neighbouring loop of bowel, the two loops being kept together by a series of interrupted sero-serous sutures placed around the site of the perforation: if one may use the expression, it is an entero-anastomosis without communication, in which the mucous lining of the damaged loop at the site of the perforation is replaced by the serous coat of the adjacent loop.[1] The necessary conditions for compulsory entero-anastomosis are provided when two large perforations of corresponding size in parallel loops are found lying together: the manner in which it is performed will be described later.

Such conditions scarcely ever occur except in cases of gunshot wounds, and this method of simple anastomosis of two opposed openings has sometimes given successful results while obviating the necessity for two distinct sutures, and sometimes the risk of a serious reduction of the calibre of the intestine. But it can never be anything better than a compulsory method of very exceptional application: indeed, it may very readily occur, that in performing these chance anastomoses two very distant segments of intestine are joined together, and may ultimately give rise to serious functional disturbances.

3. Complete Ruptures. Resection of the Damaged Loop. End-to-End Anastomosis. Lateral Anastomosis.

Thus far we have considered only those partial intestinal lesions in which lateral suture was practicable. Excluding cases where the treatment is complicated by the number of the lesions, these are the conditions most favourable to success.

It is a more serious matter when a **complete rupture** has taken place, or a loop has been so damaged as to necessitate **immediate resection.**

The presence of *multiple perforations* in a very short length of intestine,

[1] For the uses of omental grafts, see farther on, under PERITONITIS FROM PERFORATION.

or a *very large loss of tissue*, or an *extensive patch of gangrene*, which would only allow of suture at the expense of acute angulation or serious narrowing of the bowel, *an infiltrated, discoloured and flaccid loop, mottled with greyish or brownish blotches in a hopeless condition of necrosis*—these are the most common indications for immediate resection.

Faced with these grave conditions, rapid decision is required; half measures must be avoided, and also impossible procedures which one may be compelled to abandon after having lost precious time over them: for the patient, time is life; recovery will often depend on prompt decision and careful execution.

Intestinal and Mesenteric Resection.—Intestinal resection is performed in the following manner:—

Draw the injured loop outside the abdomen, and with it a length of the intestine sufficiently long to allow of all the necessary manipulations being performed outside the abdominal cavity. Place folds of gauze below and around it, and do not hesitate to devote ample time to the work of properly arranging these isolating compresses. The loop is already open, it is true: but in making the double complete section of the gut a much larger channel

Fig. 275.—Forceps with long curved and elastic blades for temporary occlusion of the intestine.

must necessarily be produced, whereby intestinal contents may escape to soil the operation field and infect the surfaces which have afterwards to be sutured. Therefore, in order to prevent the escape of fæcal matter, and also to obtain temporary hæmostasis, the first step is to provide compression of the two intestinal ends in healthy tissue two or three inches beyond the points at which the sections are to be made; this must be done in such a way that while the gut is safely occluded, the vitality of its wall is not impaired.

The compression may be exercised by **the fingers of a capable assistant**, who, resting his two hands lightly on the patient's abdomen in a convenient and steady position, grips the two ends as shown in *Fig. 255*: but this is a fatiguing and rather troublesome method, owing to the readiness with which the gut slips away, and is not so good as mechanical compression.

In *Fig. 275* a special intestinal clamp is figured, but special instruments are not indispensable, and may quite well be replaced by one or other of the following plans:—

Cover the jaws of *two curved clamps or two pairs of long Kocher forceps* (*Fig. 276*) with pieces of drainage tubing, and apply them to the intestine, tightening them just sufficiently to close the lumen and to keep the walls in close contact. Or you may cut a *flat band of aseptic gauze*, composed of several thicknesses about ¾ inch broad; tear a small hole in the mesentery between two vessels with a pair of dissecting forceps, draw the gauze strip through and, after tightening it sufficiently, knot it on the free border of the bowel, or better, perhaps, instead of knotting them, the two ends may be twisted together and fixed with a pair of pressure-forceps. Take care that the gauze strip where it lies in contact with the intestinal wall is not twisted into a cord, but is applied flat, surface to surface.

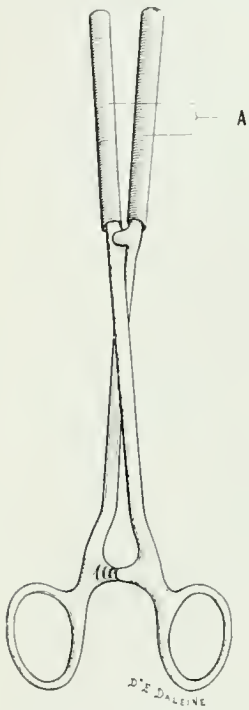


Fig. 276.—Kocher's forceps, the blades covered with drainage tubing, to be used as an intestinal clamp. (A) The drainage tubes covering the blades.

A piece of *drainage tubing* passed and secured in a similar manner may be advantageously substituted for the gauze.

We have often employed these methods of preventing extravasation of the intestinal contents, and in default of special instruments they answer excellently, provided that the ligature is applied at a sufficient distance from the line of section, and that the two ends of the gauze strip or rubber tube are drawn tightly enough to prevent its slipping about like a ring during the course of the subsequent manœuvres.

The division of the mesentery demands the greatest care: it ought to correspond exactly to the line of section of the gut, and no portion of the latter, however small, ought to be left stripped of its sero-vascular pedicle. If the mesentery is lacerated or contused over a large extent, there must be no hesitation in removing a sufficiently long segment of the gut to allow of the mesenteric section being made in healthy tissues.

If the extent of the proposed resection is not great *the mesentery may simply be divided at its intestinal insertion*, vessels of any size being caught as they are encountered, and immediately tied; then a silk thread is passed in and out through the thickness of the mesentery, close to its free border, which is gathered into folds when the ligature is drawn tight. When the mesentery is thick and fatty the stump is apt to be inconveniently large when treated in this manner. The detached mesentery may also be doubled into a fold, which will then be sutured to the intestinal border and the adjoining mesentery (*Fig. 278*) by a few interrupted sutures or by a continuous suture.

In cases of extensive intestinal resection it is better to boldly excise a wedge of the mesentery without preliminary ligatures; the base of the

wedge will correspond exactly to the length of intestine to be excised; the apex need not be more than three or four inches distant.[1]

The section of the intestine is made and the cut margins are carefully cleansed: then by means of *another pair of scissors* the two sides of the mesenteric wedge are divided, one after the other, by a series of small cuts, the vessels being seized with Kocher forceps as they are cut.

The mesenteric vessels are very friable, and tear readily under the traction of the forceps if they are not immediately ligated. Therefore tie everything that bleeds, and then have the cut edges lightly compressed under a piece of folded gauze, which covers and protects them while the

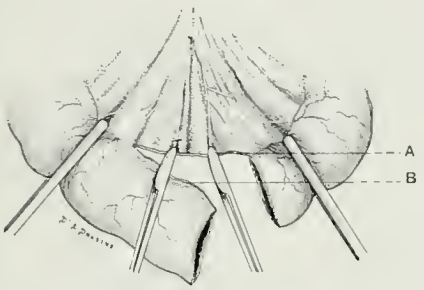


Fig. 277.—Mesentery detached from its intestinal insertion. (A) Forceps compressing the mesenteric vessels. (B) Mesenteric border of the segment of intestine to be resected.

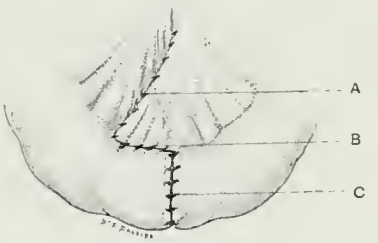


Fig. 278.—Detached portion of mesentery folded laterally and sutured. (A) Suture to the neighbouring mesentery. (B) Suture to the border of the intestine. (C) Circular suture of the bowel.

operation is continued: the final continuous suture, which will bring the margins of the gap together, will check any oozing which persists.

Proceeding methodically and quickly in the manner described will save both time and blood.

The section of the intestine will be made as already said at a distance of about two inches from the compressing forceps or ligatures: it is advisable, if the loop has not already emptied itself through the wound, to close each of its extremities with a clamp, and thus prevent any escape of the contents or further contamination of the operation field: when operating on a loop which is still intact, it should be emptied before the occluding forceps or ligatures are applied, by forcing the contents upwards and downwards.

It is always advisable to make the sections of the bowel in an *oblique direction* if it is intended to join them end to end, oblique from the free border towards the mesenteric border, so that more of the former is sacrificed than of the latter: in this way any contraction of the lumen of the gut due to the suturing is neutralized, and at the same time the blood-supply to the cut margins is assured. Notwithstanding the temporary

[1] If it seems advisable to effect preliminary hæmostasis of the mesentery, the operator will proceed as described later on (see GANGRENOUS STRANGULATED HERNIA).

compression there is always a considerable amount of oozing from the cut ends; but this is easily checked by the suture.

The two ends are now ready to be dealt with; if they are wide they may be united directly by *end-to-end anastomosis*; but as a general rule *lateral anastomosis* must be considered the method of choice.

End-to-End Anastomosis.—We assume that the two ends are of approximately *equal calibre*, as is usually the case when resection is required for the results of injury; farther on we shall see what must be done with two unequal ends. (See INTESTINAL OBSTRUCTION.)

The methods of performing enterorrhaphy are numerous; no good purpose would be served by describing them all, for their interest would be to a large extent merely historical. Under another heading we shall study the use of the different anastomotic buttons and bobbins. (See INTESTINAL OBSTRUCTION.) In our opinion these ingenious appliances, of which Murphy's button is still the type, have rendered valuable services in their day in the surgery of the intestines, but that day is past, and they are now of value only in very exceptional conditions: *the natural, simple, and truly surgical method of uniting two ends of intestine is to suture them*, and that is the method which one should learn to carry out quickly and well.

A careful study of the figures will explain much better than a detailed description how the suturing is to be done.

The resection of the mesentery and intestine has been performed in the manner described above: the two ends lying outside the abdomen are resting on and surrounded by gauze compresses.

It is well to pass two sutures through each end, one at the free, the other at the attached border at a distance of a quarter inch from the cut margins, each suture grasping the whole thickness of the seromuscular coat; the corresponding pairs of these guiding sutures will then be secured together in the jaws of pressure-forceps, and will serve to steady the two ends, to turn them over and to stretch the suture line, and, if held by a good assistant, will very greatly facilitate the work of suturing.

1. **The Posterior Serous Suture.**—Begin by suturing the serous surfaces of the two posterior walls together; the first loop (C, *Fig* 279) of the continuous suture is introduced at the superior (the mesenteric) border, and the short end of the thread is at once secured and fixed by seizing it with pressure-forceps; the long end continues the suturing in a straight line towards the free border, the needle at each stitch taking a good hold of the seromuscular coats and picking up folds of the intestinal wall at least an eighth of an inch wide. At the inferior border of the intestine the suture is stopped; the thread is not cut, but is seized with a pressure-forceps which keeps it taut. This completes the posterior half of the serous suture.

2. **The Inner Suture.**—Now introduce the posterior half of the inner suture. This will include *all the coats in its grasp*, the needle at each stitch passing through the *whole thickness of the two walls*, joining them together by their cut edges like any other tissues; the stitches are therefore perforating; but the outer broad sero-serous suture, already completed

posteriorly, serves as a protective barrier against possible infection by way of the stitch holes. This suture has the merit of being rapid: it produces firm mechanical union between the two ends, and is hæmostatic.

The inner, like the outer suture, begins at the superior border, and is continued from above downwards: the short end of the thread (A, *Fig.* 280)

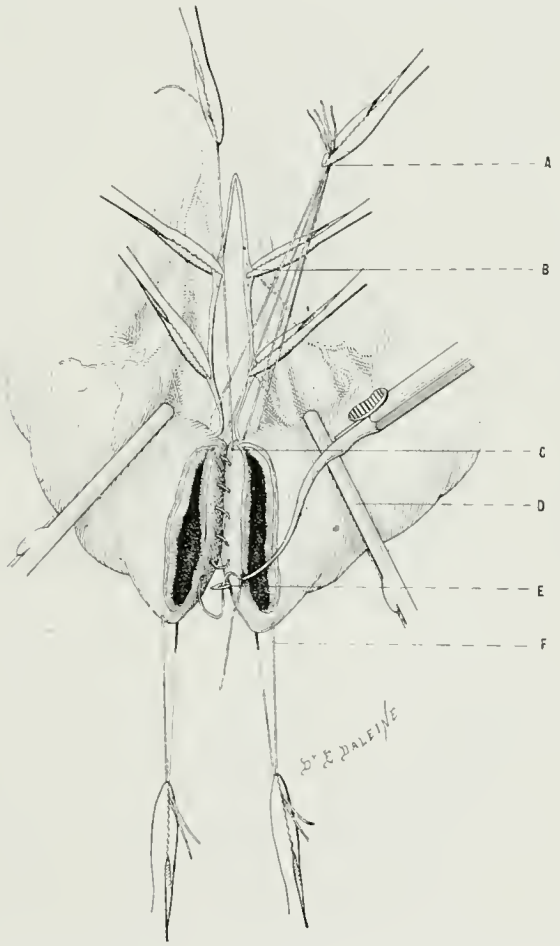


Fig. 279. End-to-end anastomosis. First step: posterior half of the outer serous suture. (A) Superior pair of guiding sutures, held by pressure-forceps. (B) Cut edges of the mesentery; forceps are applied to the vessels. (C) First turn of the posterior serous suture, the end is left long and is secured by forceps. (D) Intestinal clamps. & (E) Needle introducing the posterior serous suture. (F) Inferior guiding loops.

is left in the jaws of a pair of pressure-forceps; the long end when it reaches the inferior border changes its direction and pursues its course around the anterior half of the circumference of the intestine, forming the anterior or returning portion of the inner suture, always including the whole thickness of the walls in its grasp, and being introduced quite close to the cut edges in order to minimize as far as possible the reduction of the calibre of the gut.

When the suture reaches its starting point, after having traversed the circumference of the intestine, it is completed by knotting the long end of the thread to the short one, which had been reserved for that purpose.

3. **The Anterior Serous Suture.**—The intestine is now closed

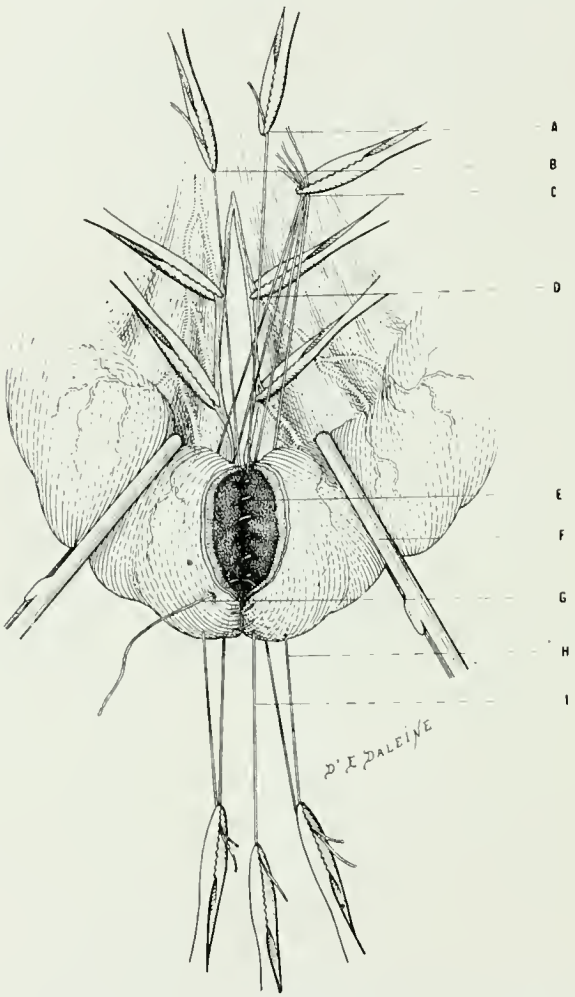


Fig. 280.—End-to-end anastomosis. Second step: the inner suture. (A) Short end of the inner suture, held in reserve and secured by forceps. (B) Short end of posterior serous suture, also held in reserve and secured by forceps. (C) Superior pair of guiding sutures. (D) Cut mesenteric edges. (E) Posterior part of the inner suture. (F) Intestinal clamps. (G) Long end of the posterior inner suture which has been carried round the free margin of the bowel and is now being used to form the anterior part of the inner suture. (H) Inferior guiding suture. (I) Long end of the posterior serous suture.

and its continuity re-established, and to complete the anastomosis it only remains to introduce **the anterior half of the serous suture.**

Take up once more the long end of the first suture which had been laid aside at the completion of the posterior line (I, *Fig.* 280); make sure that

the last stitches have not slackened, and then proceed to bring together the serous surfaces of the anterior walls in the same manner as posteriorly, with the same technique and with equal care (*Fig.* 281). Terminate the suture at the superior border by knotting together the two ends in the

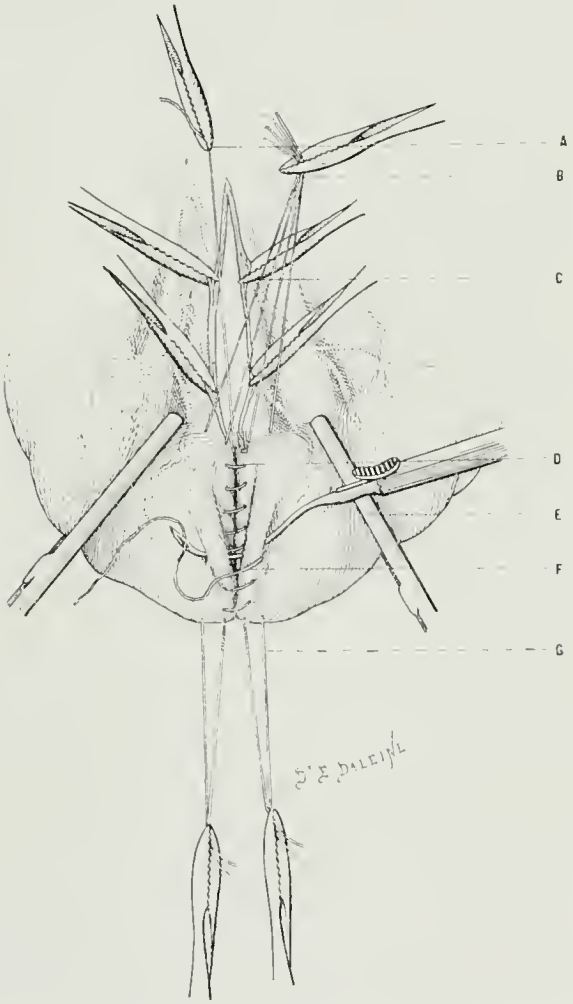


Fig. 281.—End-to-end anastomosis. Third step: the anterior serous suture. (A) Short end of the posterior serous suture. (B) Superior pair of guiding sutures. (C) Mesenteric edges. (D) Anterior deep suture. (E) Intestinal clamps. (F) Anterior serous suture. (G) Inferior pair of guiding sutures.

same manner as with the inner suture, and the anastomosis is finished. The four guiding loops may then be removed or the corresponding pairs may be tied together forming two supplementary mattress sutures at the borders of the intestine (*Fig.* 282).

4. **The gap in the mesentery,** the two lips of which are now in

contact, or even overlapping, is closed by a continuous suture (*Fig.* 282), or by a series of interrupted sutures extending along the fissure and a little beyond its upper end. Great care must be taken, especially close to the intestine, to avoid puncturing any vessel.

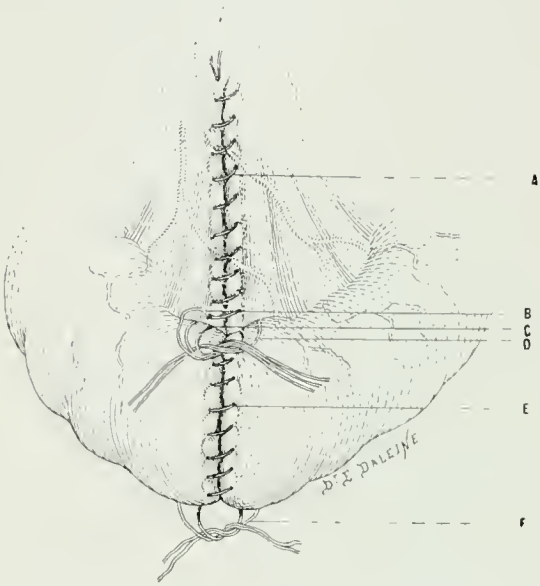


Fig. 282.—End-to-end anastomosis. The suturing of intestine and mesentery is completed. (A) Continuous suture of mesentery. (B) Terminal end of the suture. (C, D) Superior pair of guiding sutures being knotted together. (E) Line of union on the anterior aspect of the intestine. (F) Inferior pair of guiding sutures being knotted together.

As already mentioned, it is at the mesenteric border that union is most commonly defective. When the method is adopted which we have just described, both sutures begin at the difficult point; further, it is a good practice to ensure perfect closure by introducing one or two interrupted sutures at that point in the manner depicted in *Fig.* 268.

The temporary clamps or ligatures are now removed, and the operator by gentle pressure verifies the permeability of the sutured loop, which soon regains its normal outline and appearance. It only then remains carefully to wipe the mesentery and intestine in front and *behind* with a moist aseptic swab, to remove the isolating compresses one by one, and to replace the loop in the abdominal cavity.

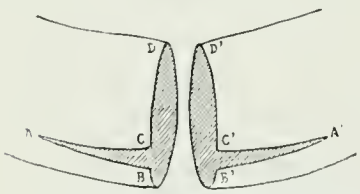


Fig. 283 (*Diagrammatic*).—Circular suture of the intestine with lateral incisions for the purpose of increasing the calibre at the junction. (*Chaput.*)

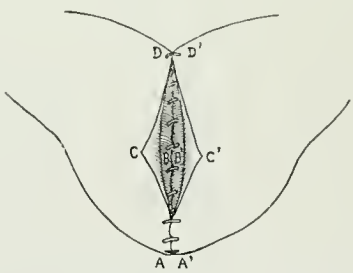


Fig. 284 (*Diagrammatic.*)—Circular suture with lateral incisions. The lateral incisions have been opened out and the resulting lozenge-shaped opening is being sutured. (*Chaput.*)

If the omentum is conveniently situated, it is a good plan to spread it out over the surface of the sutured segment, but no dependence must be placed in this external covering for neutralizing defects resulting from

faulty suturing In abdominal surgery it is always necessary to take the greatest care to avoid the formation of adhesions: for this reason the application and fixation by sutures of a slip of omentum over the line of intestinal union, with the idea of forming an extra coat, seems to us to be of doubtful utility, and sometimes dangerous. **Good union is only to be obtained by a good suture which holds adequate serous surfaces in close and continuous contact**; that is the fundamental principle by which the surgeon must be guided.

We have said that the chief risk associated with end-to-end anastomosis is that of unduly narrowing the intestine: this danger may, however, be materially reduced by the technique employed. The more regular the preliminary section of the intestinal ends, the more careful the suturing, with regular spacing and even tension of the stitches, the better will an adequate calibre be preserved in the sutured loop. It is the flaccidity of the two ends of the intestine which creates the greatest difficulties during the initial steps of the suturing: it is always a rather troublesome task to introduce the posterior half of the serous suture satisfactorily: the guiding sutures are a great help if well handled, and it is wise to devote sufficient time to this first line of suture, for if this is satisfactory the rest of the work will be carried out much more quickly.

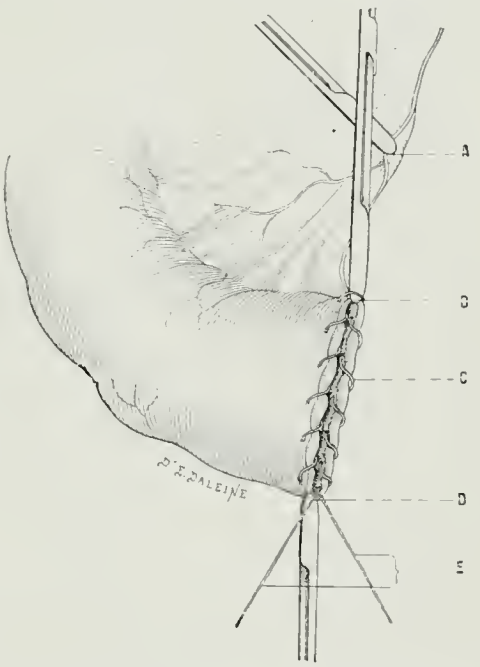


Fig. 285.—Closing the ends of the intestine by double purse-string suture.[1] (I.) First thread over-sewing the circumference of the cut edge. (A) Cut edge of mesentery, forceps compressing a vessel. (B, D) Forceps fixing and putting the two extremities of the circular section of the intestine on the stretch. (C) The thread over-sewing the cut edge of the intestine. (E) The two ends of the thread; when they are tightened and knotted the first gathering, including all the coats of the intestine, will be produced.

Finally, if the oblique section of the gut seems insufficient to prevent an undue reduction of calibre, the tendency to contraction may be counteracted by a method of **lateral incisions**: on each of the two ends an incision is made along the free border of the intestine, and the corners bounded by the longitudinal and transverse sections are rounded off: the edges of the intestine are first sutured together in the ordinary way as far as the corners of the lateral incisions, those incisions are then retracted

[1] Vollbrecht. "Vereinfachter Schnürverschluss des Darmes." (*Centralblatt fur Chirurgie*. 1900, No. 27, p. 684.)

in a direction transverse to the long axis of the gut, and the suturing is continued round the opposed borders of the *lozenge-shaped opening* (*Figs.* 283 and 284). The method is in fact an application of the one already described when considering the treatment of wounds of the intestine involving loss of tissue.

Although it is well to be acquainted with this ingenious plan, practically it is scarcely ever used, it being much better to employ the excellent method of *lateral anastomosis.*

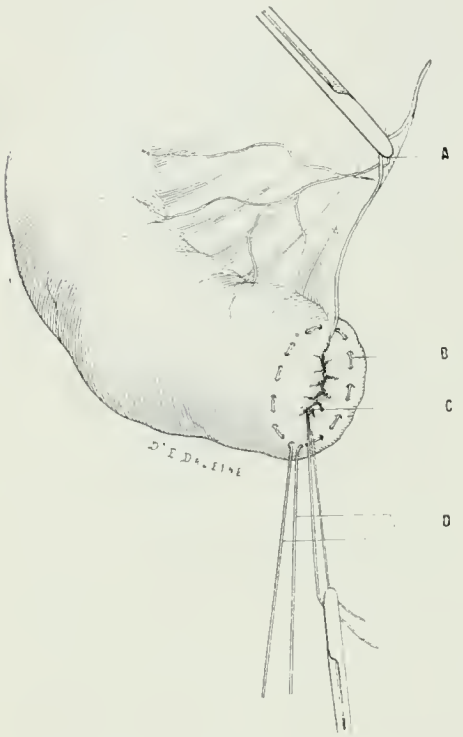


Fig. 286.—Closing the ends of the intestine by double purse-string suture. (II.) Second thread passed circularly in and out in the thickness of the seromuscular coats. (A) Forceps compressing a mesenteric vessel. (B) The outer purse-string. (C) The first thread knotted, and the deep gathering. (D) The two ends of the second thread when they are tightened and knotted the outer sero-serous gathering will be produced.

Lateral Anastomosis (*Plate VI*).—The operation comprises three successive steps: (1) *The closure of the upper end:* (2) *The closure of the lower end:* (3) *The lateral union and anastomosis of the two ends.*[1]

With care and some practice, the three steps can be very quickly executed, and notwithstanding the apparent complexity, it is in reality the method of election.

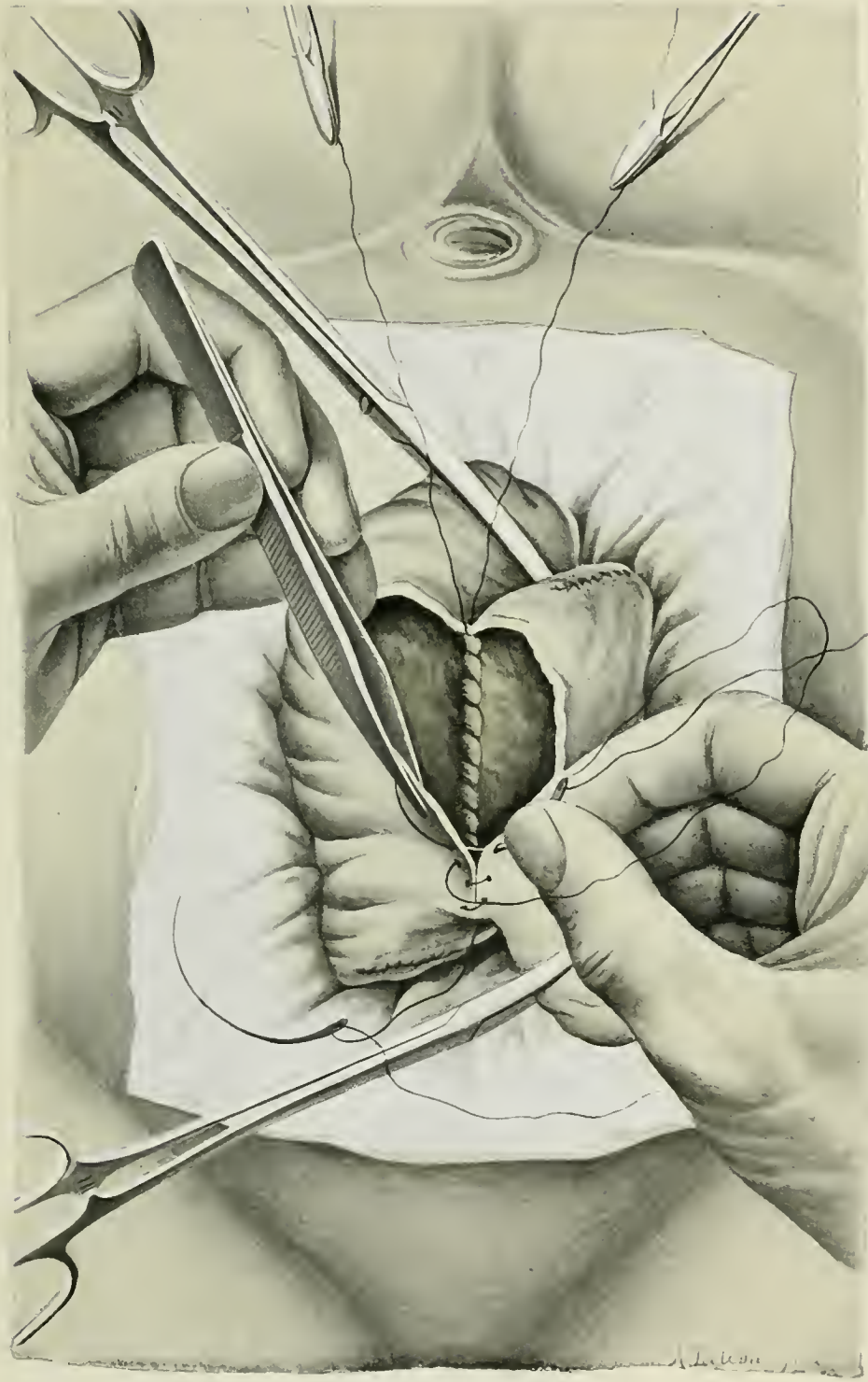
First close the two ends of the intestine by invaginating them. To do this apply a continuous suture, including all the coats, to the two edges of the open end, then bury the first suture line by a second broad serous suture (*Fig.* 288). Or again, the two ends may be closed by purse-string sutures, in the manner shown in *Figs.* 285, 286 and 287. The latter method has the advantage of diminishing the size of the two blind ends.

Now lay the two closed terminal segments side by side, so that they overlap by at least three inches, their mesenteries also overlapping.[2] A

[1] Strictly speaking it is a latero-lateral anastomosis. The method of performing termino-lateral anastomosis by implantation will be described later (see STRANGULATED HERNIA).

[2] The mesenteries must be united by a few points of sutnre to insure adhesion between them, and the obliteration of any gaps.

Plate VI.—Lateral anastomosis. The two ends of intestine are drawn outside the abdomen and surrounded by compresses. The inner suture is being continued from below upwards along the anterior margin of the openings; above, are shown the short ends of the posterior serous sutnre and the inner suture; below, the long end of the posterior sero-suture, threaded on a needle, with which the serous suture will be completed in front



LATERAL ENTERO-ANASTOMOSIS

longitudinal opening is now to be made on each of the opposed surfaces, which will establish a wide communication between them and give free passage to the intestinal contents.

First introduce two fixation threads at the two extremities of the site of the proposed anastomosis. These threads, picking up the sero-muscular coats of the two opposing walls at corresponding spots, and being held by pressure-forceps, serve to maintain the two segments in contact, and by longitudinal traction render the tissues taut, and greatly facilitate the work of suturing.

Now introduce the *posterior serous suture:* it must be at least two inches in length, carefully placed, and with regular intervals between the stitches. The rest of the operation will be performed much more quickly once this first line is properly completed. As before, in performing end-to-end anastomosis, secure the long end of the thread with a pair of pressure-forceps to be subsequently employed for the anterior serous suture (*Fig.* 288).

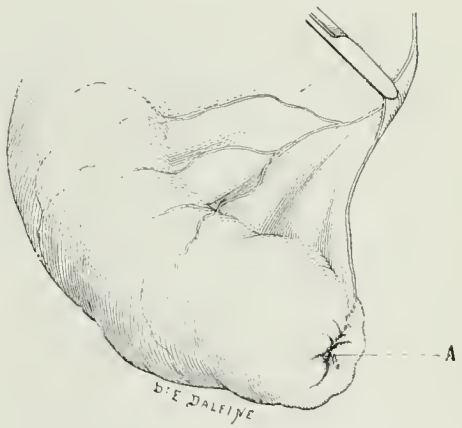


Fig. 287.—Closing the ends of the intestine by double purse-string suture. (III.) The end of the intestine is completely closed. (A) The sero-serous gathering.

The two intestinal limbs must now be opened. Make the incisions with light strokes of the scalpel *parallel to and about one-eighth inch in front of the posterior suture line.* The bleeding at this stage is often rather profuse, but there is no occasion for alarm; it will be easily checked by the suture. Should there be any difficulty in dividing the flaccid and wrinkled mucosa with the knife, raise up a fold with dissecting forceps, open it with the scissors, and extend the incision upwards and downwards. The openings into the bowel ought always to be of good size, because they are diminished somewhat by the suturing, and later, a further degree of contraction is to be expected during the healing process.

Unite the two posterior lips by a second continuous suture (*Fig.* 289), including the whole thickness of the two walls, and having the stitches carefully introduced and tightened to ensure accurate adjustment of the two mucous edges. Continue this suture uninterruptedly around the lower extremity, then along the anterior border of the opening (*Plate VI*), and when finished at the upper extremity, go back to the long end of the posterior serous suture, which had been previously laid aside secured by a forceps, and continue it in its turn along the anterior semi-circumference to terminate at its starting point, thus completing the entire serous suture (*Fig.* 290).

In short, the method of suturing is identical with that employed in performing end-to-end anastomosis, and which has been already described. When the ends of the two intestinal segments are retracted or of unequal calibre, it is always safer and easier to join them laterally than end-to-end.

In certain conditions the anastomosis may be made by means of a button instead of by suturing.

When the suturing is completed and the wounded loop replaced, attention must be given to the cleansing of the peritoneum, and to drainage: these two points are of the utmost importance.

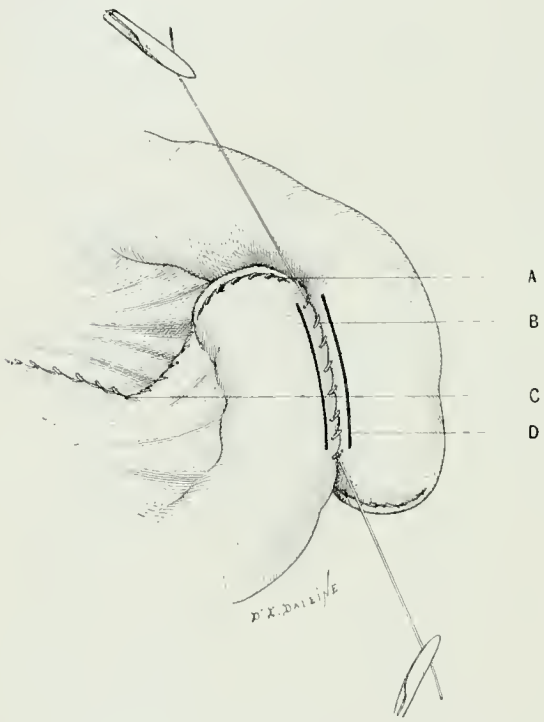


Fig. 288.—Lateral anastomosis. First step: closure of the two ends. Posterior serous suture. (A) The closed lower end. (B) The posterior serous suture. (C) Cut edge of mesentery joined to the underlying mesenteric surface by a continuous hæmostatic suture. (D) Lines of the incisions about to be made in the approximated ends.

If the contaminated area is definitely limited and occupies one of the lower abdominal regions; if the rupture is small and the amount of extravasation scanty, *dry cleansing* with gauze swabs or compresses is sufficient if well and carefully done, and is free from the danger of causing diffusion of septic matter.

When the rupture has occurred at the centre of the abdomen, as is frequently observed after injuries caused by horse-kicks, or if there are multiple perforations or great extravasation of intestinal contents, **peritoneal lavage with warm boiled water,** or better still with **boiled saline solution,** is sometimes useful. Later on we shall return to the method of employment, and the indications for these measures; here we will merely mention that if used in sufficient quantity (3–4 quarts), peritoneal lavage exercises a doubly beneficial action: it cleanses the peritoneal cavity, and also produces a rapid and well-marked elevation of the blood-pressure, owing to the extensive absorption of fluid by the enormous serous surface. It constitutes at the same time a cleansing agent and a large infusion of normal saline solution.

In our opinion *drainage* is always indicated: in the first place, when there is a rupture or a perforation of intestine, stomach, gall bladder, or urinary bladder, with considerable extravasation; and secondly, where there has been a large effusion of blood, and in which even a moderate amount of oozing persists after the effused blood has been evacuated and the bleeding vessels secured.

The drainage must be obtained by means of a *drainage tube* surrounded by folds of gauze; it is important that the tube shall reach quite to the bottom of the area to be drained, and the gauze must be disposed lightly around it, not packed tight enough to act as a plug in the external opening. The charges brought against the so-called Mickulicz drainage are due to a failure to recognize the real indications for the use of that excellent method; a "Mickulicz drain" is not drainage in the proper sense of the term, but simply a method of packing; in dealing with an area already septic, or supposed to be so, the drainage tube is indispensable.

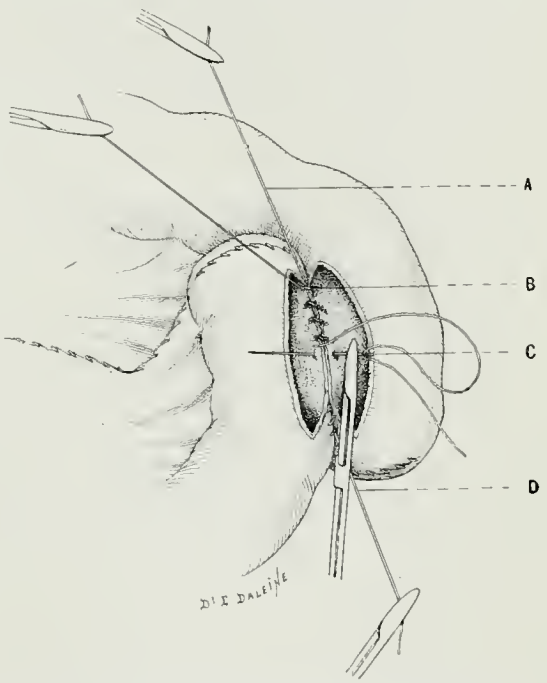


Fig. 289.—Lateral anastomosis. Second step: The lateral openings in the two ends; introducing the posterior half of the inner suture. (A) Upper end of the posterior serous suture. (B) Starting point of the inner suture. (C) The inner suture, the needle passing through the whole thickness of the two opposed walls. (D) The lower end of the posterior serous suture which will presently be used to complete the serous sutnre in front.

Secondary and Late Operations.—We do not always see the case immediately after the accident. Too often, instead of being in a position to discuss the advisability of early operation, we find ourselves face to face with symptoms, only too definite, if one may use the expression, of serious deep lesions. To the initial symptoms others, indicating commencing peritoneal infection, have been added, sometimes indeed all the signs of widely diffused peritonitis are present.

It is no longer a question of justifying operative measures, the need is self-evident. Rather must the surgeon ask himself in many cases, "*Is it not now too late?*"

Thanks to that deceptive doctrine of "armed expectancy," pushed beyond reasonable limits, operation is often not recommended in the early stages because there are not enough symptoms, and in the later stages

because there are too many; as a consequence the patient, who might have been saved by early decision and rational treatment, after a short period of misleading improvement, dies on the fifth, sixth, or seventh, perhaps even as late as the tenth day after the injury. This is the catastrophe always to be feared when, following the old teaching, operation is delayed until the early signs of peritoneal infection have made their appearance: what the advocates of a waiting policy term "operating in time" is "operating too late," because we know only too well from numerous cases how exceedingly indefinite and irregular are the signs of peritoneal reaction, on which some desire to base the indications for operation.

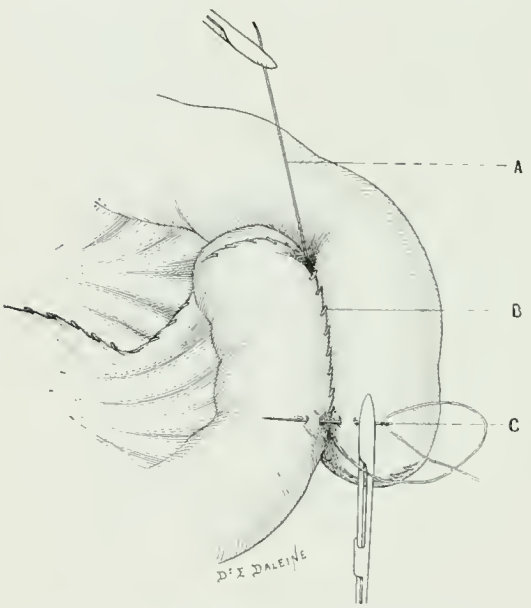


Fig. 290.—Lateral anastomosis. Third step: Introducing the anterior serous suture. (A) The upper end of the posterior serous suture. (B) The inner suture. (C) The anterior serous suture being introduced from below upwards.

Later on, a number of illustrative cases will be quoted; here I content myself with mentioning that I have on two occasions opened the abdomen of a patient suffering no pain, with no vomiting, and who, considering the accident which had happened some days previously a comparatively trivial matter, had walked into hospital a few hours before operation, and yet in each case the peritoneal cavity was full of pus and the patient suffering from generalized peritonitis.

Should the surgeon not be called until this late stage of the illness, and should he find the patient suffering from widespread peritoneal infection, ought he to refrain from operating and refuse to take the responsibility of his death? I do not think so, and have already expressed my opinion with regard to the doctrine of "letting the patient die quietly." The use of saline infusions has enabled us to extend the limits of beneficial surgery, and, although the prognosis in these late operations is exceedingly bad, some striking cases have shown that even when apparently most hopeless, it has been possible to save life: that is sufficient justification for operating.

It may be worth while to relate briefly one of these cases:—

Case 22.—A lad, 17 years of age, had been kicked in the abdomen by a horse, and had received no treatment for twenty-six hours; his general condition was most alarming; the face was pinched, the tongue dry, the pulse 130 per minute and very feeble, the temperature 97·4°, and the abdomen greatly

distended. Since the accident he had continued vomiting almost without cessation, and the vomited matter had become black and fæculent. On opening the abdomen a stream of pus and intestinal contents escaped; the intestines were covered with adherent purulent lymph; on the ileum I found a perforation with everted margins the size of a two-shilling piece. The rupture was closed, the peritoneum washed out and drained, and the operation terminated as speedily as possible, because death seemed imminent.

I may add that I have never seen a case in which a fatal ending seemed to be more certain. For two days the condition remained apparently hopeless: fæcal vomiting persisted, and there is no need to indicate the usual serious significance of that symptom. However, the infusions—intravenous and subcutaneous—by the aid of which we had been able to carry through the operation, were continued in daily dosages of five pints. At the end of nine days the patient seemed likely to recover; by that time he had received about fifty pints of saline solution into his venous system. After a prolonged convalescence he ultimately made a complete recovery.

These **late laparotomies** performed at the height of the peritonitis call for special methods: rapidity of operation is of capital importance. If there are multiple intestinal lesions, the necessity for closing them all seriously complicates the operation, and leaves but little chance of a successful result. But we cannot foresee the occurrence of such complications, nor if we could should we be justified in pronouncing the case to be absolutely hopeless. Our duty under these circumstances is to make the operative methods as simple as possible.

In the presence of a complete rupture or of a perforated and gangrenous loop necessitating resection, it will sometimes be the best practice not to attempt enterorrhaphy; the operation can be completed more quickly **by fixing the two ends in the abdominal wound.** Copious warm irrigation of the abdominal cavity, multiple drainage of the chief focus, of the pelvis and the iliac fossæ, and incomplete closure of the wound, which is left open in its lower part, constitute the indispensable steps under such urgent conditions.

In other cases urgent indications for laparotomy appear only at a considerable interval of time; after the initial shock all the symptoms may diminish to such a degree that there is no reason for suspecting the existence of any serious lesion, or the patient may even have passed from medical observation. Subsequently, unexpected septic phenomena make a sudden appearance. This may happen under the following conditions:—

1. **The injury has produced a large hæmatoma** in one or other abdominal region without any gastro-intestinal lesion: it remains latent for a time, then becomes infected, and the infection spreads to the surrounding peritoneum. The following is a good example of these delayed infections and secondary peritonitic lesions:—

Case 23.—A man, about 40 years of age, had received a violent blow in the left hypochondrium; he received no medical attention, but remained in bed for two days; then, feeling almost well, he returned to work. Ten days later he was brought to the Beaujon Hospital, where he made no mention of his accident, from the effects of which he considered himself to have completely recovered. He was therefore taken to the medical wards, and it was only when carefully

interrogated that he gave any definite information with regard to the preceding injury. His general condition was then very alarming: his face was pinched and had the anxious peritonitic appearance, the pulse was feeble and very rapid, and there was frequent vomiting of greenish fluid. The abdomen was painful, tense, and distended, the tenderness being particularly noticeable in the left hypochondriac region. By palpation and percussion a large mass was detected extending inwards almost to the middle line in the epigastrium, and descending with a rounded border into the umbilical region. In all this area there was a quite definite prominence, perfectly evident on oblique inspection. Deep-seated fluctuation was obtained, although the pressure was very painful. The diagnosis was: large hæmatoma, perhaps suppurating, certainly infected, with extension of infection to the neighbouring peritoneum.

Operation was immediately undertaken. I made a long incision at the outer border of the left rectus muscle over the most prominent part of the swelling; after incising the abdominal wall I came down upon a thick, blackish membrane which evidently covered a collection of fluid. As soon as the membrane was opened a considerable quantity of dark blood and clots escaped, and I penetrated into an enormous cavity, everywhere closed, and at the bottom of which it was exceedingly difficult to recognize the neighbouring organs. The character of the blood indicated that the hæmorrhage had ceased, and it would have been unwise to incur the risk of exciting fresh bleeding by seeking too closely to discover if the primary lesion had been a partial rupture of the spleen or of a large pancreatico-splenic vessel; in front, the wall of the cavity in the greater part of its extent was adherent to the peritoneum; the rest of the anterior surface was formed by thickened and infiltrated omentum, which shut off and protected the general peritoneum. I irrigated the cavity with warm boiled water, left two large drainage tubes in it, and sutured the extremities of the abdominal incision. The bad symptoms disappeared forthwith, and the patient was discharged, cured, two months later.

In cases of this kind it is important not to disturb the existing hæmostasis and limiting adhesions. Open the cavity as directly as possible, evacuate the contents and cleanse it, respecting the adhesions and exercising great gentleness in the removal of the deeper-seated clots; and provide good drainage. If it appears necessary to open the general peritoneal cavity for purposes of cleansing and drainage, this ought not to be done until the procedure just described is completed.

2. **The perforation is situated on the posterior wall of the cæcum or colon:** it is small and gives origin to a retro-peritoneal fæcal infiltration which extends slowly, and only causes serious symptoms after the lapse of some time.

Another possibility is that the perforation may not at first have been complete. In some cases of rupture produced by crushing, the inner coats —muscular and mucous—of the intestine are torn, but the serous remains intact; later on this thin serous layer also ruptures, and infection of the general peritoneal cavity at once ensues.

It is the same when a slough of the intestinal wall—intact and forming a barrier to the escape of intestinal contents during the early days succeeding the injury—suddenly separates; practically, however, this theory of secondary peritonitis due to separation of a slough must not be pushed too far. As a matter of fact it applies only very exceptionally; a considerable number of the cases of peritonitis complacently attributed to an accident of this kind are really due to primary perforation, in which the evolution

of symptoms has been delayed, and which might have been prevented by early operation.

In secondary laparotomies undertaken for either of the foregoing conditions, considerable difficulties are often encountered; these are due to the extensive adhesions, to the seat of the perforation, which is more or less hidden and not to be easily discovered, and to the infiltration and thickening of the extra-peritoneal tissues.

3. Lastly, **Contusions of the abdomen may be followed by traumatic peritonitis, even in the absence of any visceral lesions.** In these cases the peritonitis is generally of rather slow development. M. Xavier Delore has reported an interesting example.

In one of our own cases, that of a man aged 36 years, who had fallen into the ditch outside the Paris fortifications, and who presented most definite signs of peritoneal infection, on opening the abdomen we found nothing but a fairly abundant effusion of blood, and no trace whatever of visceral injury: the patient died, and a careful post-mortem examination revealed nothing further.

This rare form of traumatic peritonitis has been investigated by M. Heusch,[1] who has succeeded in collecting ten cases: of these, however, in only five was a minute post-mortem examination made. The condition appears most often to follow a widespread contusion of the abdomen; the infection probably results from the passage of septic organisms through the paralyzed intestinal walls.[2]

However that may be, in our opinion it is always advisable to exercise scepticism with regard to the exact nature of these conditions, and it is necessary to perform laparotomy as early as possible, and to admit the non-existence of a causative lesion only after a careful and methodical intra-abdominal exploration [3]

WOUNDS OF THE ABDOMEN.

Here, even in the absence of any visceral lesion, the simple fact of penetration, if it is established, indicates a serious danger, and necessitates treatment on the lines presently to be detailed.

We say if penetration is established; but to determine that point in doubtful cases, neither probe, director nor even the finger must ever be employed, nor yet any of those timid, uncertain and dangerous exploratory methods so long and generally advocated. In the case of a wounded abdomen, just as with a wound of the skull, there is a *rational method of examination* which should always be followed.

[1] Heusch, *De la péritonite traumatique par contusion de l'abdomen, sans lésions viscérales apparentes.* Thèse de Lyon, 1898.

[2] The same mechanism of infection exists in strangulated hernia and intestinal obstruction. (See those headings).

[3] These cases are particularly serious: in the ten collected by Heusch, there was no operation in six, and all of these died; laparotomy was performed in four, and two patients recovered.

The diagnosis of perforation, and even of serious visceral lesions, is often at once evident; but for the present I assume that we have to do with a small wound from which there is very little bleeding and which is not associated with any definite symptoms. First of all enquire as to the circumstances of the injury; examine the weapon if it is available, and ascertain if possible to what depth it has penetrated; some useful information may thus be acquired, but in any case do not allow further steps to be delayed by these enquiries.

Disinfect the hands and the surface of the abdominal wall as if for an operation.[1] With fingers or retractors separate the edges of the cutaneous wound and inspect them. Continue the examination step by step through the successive layers of the abdominal wall, carefully cleansing each with gauze swabs before passing on to the deeper tissues. If necessary extend the extremities of the wound so that it may be possible to examine the deeper layers in a good light and not at the bottom of a blind pit. As a matter of fact, the wounding instrument has often entered obliquely, making a sort of tunnel in the tissues, the bottom of which is only accessible after adequate enlargement of the superficial wound.

If the transversalis fascia and the parietal peritoneum, when thoroughly exposed, appear to be intact; if they are not tense nor discoloured; if the blood has ceased to flow from the depths under the edges of the muscle wound; if all these agree with the information received, and above all with the symptoms and signs one has personally observed, the conclusion may be formed that the wound is not penetrating, and one may proceed to complete the work of disinfecting the track, then to repair the musculo-aponeurotic planes of the abdominal wall by a series of continuous sutures (*Figs.* 294 and 295); finally to suture the skin, and over all to apply a good dressing consisting of a thick layer of wool and a broad flannel binder (*Figs.* 297, 298, 299, 300). One has now done an excellent piece of work by preventing the septic complications and the ventral hernia which so often result from these wounds.

When in doubt, operate: that is the wise and sensible rule.

If the wound is penetrating, the operation must naturally be continued, and becomes a more difficult business. A study of the

[1] This exploration—which may be the first step in a most troublesome operation—should never be undertaken hastily, and without proper precautions, at the scene of accident. *The wound must not be touched* until it can be done aseptically, nor, if it can be avoided, must the wound be touched even under favourable circumstances by any one who does not feel conscientiously able to carry the task, with its varied possibilities, to a satisfactory conclusion. It is much better to transport the patient at once. Madelung lays great stress on the importance of these practical points; according to him a journey, even of some hours' duration, causes little harm to a patient with an abdominal wound, but the introduction of any provisional sutures, any attempts at reduction, even when there is considerable protrusion of viscera, must be avoided. He cites the case of a wounded man who, in addition to other serious lesions, had a couple of feet of intestine protruding from the abdomen for twenty hours, but who nevertheless recovered, thanks to the fact that no one had touched the wound. (Madelung, "Einige Grundsätze der Behandlung von Verletzungen des Bauches." *Beitr. zur klin. Chir.*, 1897, Bd xvii., III, p. 695).

various clinical possibilities will demonstrate the necessity for this further exploration.

We distinguish: (1) *Small wounds* caused by stabbing or cutting instruments; (2) *Large wounds* with protrusion of viscera; (3) *Gunshot wounds.*

I.—SMALL WOUNDS.

The most common injuries belonging to this group are stab-wounds inflicted with knives, swords, daggers, etc.

In one group of cases the signs are so characteristic that there can be no doubt as to the extent of the injury and the need for immediate operation.

(*a*). **Blood is running persistently and abundantly from the wound, perhaps mixed with fæcal matter, or bile or urine.** The latter signs are pathognomonic but are only rarely observed, and it would be a grave mistake to conclude that there are no visceral lesions in cases where they are absent. Persistent hæmorrhage almost always indicates serious deep lesions, particularly when it is associated with pallor, feeble pulse, distention, and painful rigidity of the abdomen.

But one must not be misled by the absence of general symptoms, nor wait for their development before undertaking a necessary operation. Some years ago I saw an unfortunate madman who had given himself three stabs in the epigastric region with a large carving knife: two hours later, although blood still continued to ooze from the wounds, he was in no way depressed, the pulse was excellent, and assistance was required to hold him during the induction of anæsthesia; he had two large perforations in the transverse colon.

(*b*). At other times, notwithstanding the comparatively small size of the wound in the abdominal parieties, **an omental protrusion or a laterally constricted loop of intestine** may be seen. Here again operation is evidently required in the manner which we shall describe immediately. But further, I hold that safe and reasonable measures cannot be based on the presence or absence of any particular signs.

When a surgeon has been called during the hours immediately following the injury to see a patient with a penetrating wound of the abdomen, he ought, even in the absence of any suspicious discharge, persistent hæmorrhage, or any other definite sign, to enlarge the wound sufficiently to enable him to efficiently cleanse it and to make a thorough intra-abdominal examination.

That of course was not the old idea, and I, like others, have heard denunciations of useless and dangerous exploratory operations. "There are no definite symptoms, do not interfere with the patient; refrain from enlarging the wound or opening the abdomen, keep him absolutely quiet, give some opium, apply ice, and wait"—wait for the first signs of peritonitis. The doctrine expressed by these rules was sound at a time when the actual operation was quite as dangerous, if not more so, than the injury itself, and it would still be worthy of acceptance if we knew that the contact of the

hands and instruments might as readily cause infection as the dirt on the wounding instrument. That a certain number of patients recover under these expectant methods no one will deny; but that again proves nothing. Those only recover who have not been seriously infected or who have no visceral lesions, and it is impossible to determine with certainty the absence of deep lesions or of infection in advance, during the early stages, at the time when a decision must be made; the latter point in particular remains obscure, and is never cleared up until too late. To do nothing is to leave the future to chance, pure and simple; it is a tempting of fortune; and further, when the matter is carefully considered it is evident that inaction involves the assumption of a grave responsibility. If illustrations are needed they can be given in abundance.

An Italian had received a knife stab in the belly; he came on foot to the Beaujon Hospital. He had no pain, nor had he vomited: urine had been passed without difficulty, the facial expression was normal, the pulse of good quality; on the abdominal wall, a little to the right of the middle line, we found a small incised wound about an inch in length; the bleeding had ceased, the abdomen was otherwise normal in appearance, was soft and not painful, there was no iliac dullness. What case could have been more favourable for expectant treatment? What could apparently have been simpler and wiser than to cleanse the external wound, cover it up with gauze and collodion, and to keep the patient in bed? However, following our routine practice, the patient was anæsthetized, the whole surface of the abdominal wall was washed and disinfected, and the wound enlarged longitudinally; in the abdomen we found widespread effusion of blood and a large wound of the great omentum, which was still bleeding freely. The injured segment was resected after ligation, and the peritoneal cavity carefully cleansed; there was no other lesion. The abdominal wall was sutured in three layers. Recovery ensued without the slightest trouble. What advantage would there have been in such a case in waiting for the appearance of serious symptoms?

A second case will serve to show the responsibility which is incurred through not doing at once what is necessary, and all that is necessary, even though the penetrating wound apparently presents the most benign character.

A man received in the right flank a knife-stab which seemed to have produced very insignificant and purely parietal injuries; he experienced very little pain, and felt no other bad effects, the bleeding quickly ceased, and after the application of a dressing he did not remain in bed, and it was not until three days later that he decided to enter hospital. In the flank we found a wound about an inch in length, the lips of which were already adherent; the abdomen was not distended, but somewhat tender over its whole surface; the pulse was weak and the face pinched, there was no vomiting or other definite sign of peritoneal infection. The wound was enlarged, but the intra-abdominal examination revealed no trace of deep injury; there was no extravasation of blood, no false membrane; the wound was cleansed and sutured. The patient died next day with a subnormal temperature and a wretched pulse, but without any outstanding

symptoms. The autopsy revealed no lesion of the abdominal organs, no effusion of any kind; the knife had penetrated the peritoneum without injuring any of the subjacent organs; death had been due to *general infection*, primary or secondary, by way of the wound. If during the first day the wound had been enlarged, disinfected and drained, is it not possible that the fatal ending might have been prevented?

The conclusion is therefore that in the abdomen there are no insignificant wounds, or at any rate that it is impossible to distinguish those which are really insignificant. The rule of early intervention therefore remains immutable.

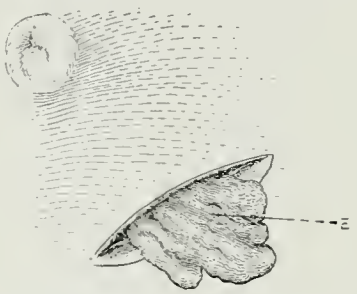


Fig. 291.—Wound of abdomen with omental protrusion. (E) Omentum.

The problem presents itself under a somewhat different aspect when from twenty-four to forty-eight hours have elapsed since the receipt of injury, and no symptoms have appeared. A minute investigation is still essential, giving due consideration to any local or general abdominal tenderness, to the pulse, the facial appearance, and to all those slight symptomatic variations from the normal which are of such importance under these circumstances. If the slightest doubt or suspicion persists, again it is advisable to open the wound freely, and to examine and treat it under ocular guidance.[1]

In this first class of penetrating wounds the technique must conform to certain definite rules.

The abdominal wall must always be prepared over a large area, well beyond the wounded region, usually indeed over its entire surface; it is impossible to foresee what enlargements of the wound or secondary incisions may be required.

1. **Lateral Laparotomy by Enlargement of the Wound.**—If the wound is single, whether it be the seat of profuse hæmorrhage, or gives issue to intestinal contents, bile or urine, or if protruding omentum or intestine is found between its edges, the first step is to enlarge it and to

[1] If no symptoms have appeared, at what time after the receipt of injury may the patient be considered out of danger? It is difficult to say. A case recorded by Budinger provides a striking illustration of the difficulty: a man, aged 22 years, had been stabbed with a knife in the epigastric region; there were no immediate symptoms, nor did any appear during the days immediately following: there was no pain, no distention: the bowels acted naturally, the appetite was good, the temperature remained in the neighbourhood of 98·4°. Treatment was limited to the application of a dressing to the wound, which was about three inches long, parallel to the left costal margin. The condition remained perfectly satisfactory till the seventh day, when suddenly the patient felt an intense pain in the abdomen, his face became livid, respiration laboured, the pulse feeble and irregular, and some distention appeared. An hour later the abdomen was opened by enlarging the original wound parallel to the costal margin: on the anterior surface of the stomach, an inch above the great curvature, a wound half an inch in length, parallel to the long axis of the organ and from which gas and stomach contents were escaping, was found: the surrounding peritoneum was perfectly normal except for some loose omental adhesions. The gastric wound was sutured, the wound drained with a strip of iodoform gauze, and the patient recovered. (K. Büdinger, "Ueber Stichverletzungen des Bauches," *Arch. fur klin. Chir.*, 1898, Bd. lvi., 1, p. 168.)

make it the starting point of the laparotomy incision if a larger opening should be required. There is reason for believing that the focus of injury may lie quite close to the primary wound under the abdominal wall, and it is therefore the shortest route for reaching the deep lesions without incurring the risk of diffusing the extravasated material. Apart altogether from these serious conditions, and when dealing with an abdominal wound which is no longer bleeding, or at most but little, and from which there has been no suspicious discharge, local enlargement is the customary and simplest practice, particularly when the wound is situated at a considerable distance from the middle line, occupying for instance the outer part of the flank or the iliac fossa. We shall return later to the question of wounds in the hypochondriac regions.

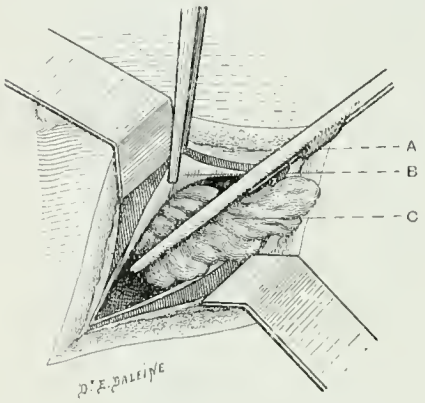


Fig. 292.—Wound of abdomen with omental protrusion. (A) Aponeurosis. (B) Parietal peritoneum. (C) Omentum seized transversely with forceps.

Certain points are to be observed in the enlargement of the wound. As a rule it should be made *longitudinally, parallel to the rectus muscle.* Enlarged in this way it gives a better exposure and leaves the muscular wall in a condition better adapted for repair. Thus a transverse or an oblique wound may be transformed into an angular or a cross incision.

The abdominal wall must not be divided *en masse* over a finger introduced directly into the peritoneal cavity through the primary wound; the skin must first of all be incised and retracted, then the muscular layers. Working in this manner the mechanical cleansing and disinfection may be completed to the bottom of the wound before the opening in the parietal peritoneum is enlarged; the last layers will be divided with the scissors guarded by a finger introduced into the peritoneal cavity, and the cut edges of the serous membrane at once secured with forceps. Let us suppose that we have to do with a stab-wound in the left flank through which omentum is protruding (*Fig.* 291), a comparatively simple and not uncommon type of wound. After the usual preliminary preparation, and with the wound sufficiently extended

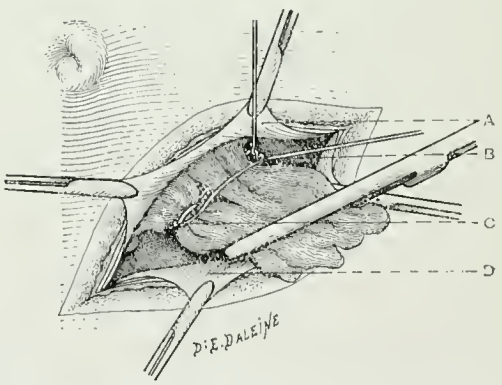


Fig. 293.—Wound of abdomen with omental protrusion. (A, D) Parietal peritoneum. (B, C) Tying the omental pedicle in healthy tissue (Lawson Tait's knot).

at its angles, draw the omentum a little farther out of the abdomen and secure it with Kocher's forceps or a small clamp (*Fig.* 292); ligate it at a good distance from the herniated portion with two chain ligatures, or by a single ligature secured by Lawson Tait's knot (*Fig.* 293); cut away the portion beyond the ligature; examine the stump carefully before the ends of the ligature are cut short, then return it to the abdomen. Have the wound margins well retracted, and see if there is any bleeding, or any other lesion within the abdomen. If everything appears satisfactory, attention must then be devoted to the repair of the abdominal wall.

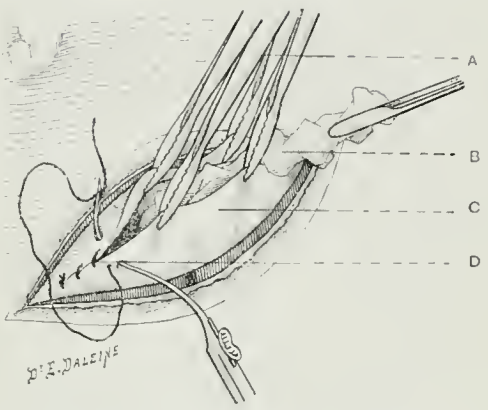


Fig. 294.—Wound of abdomen with omental protrusion (A) Forceps grasping and lifting up the peritoneal edges. (B) Fold of gauze protecting the intestine during the introduction of the suture. (C) Parietal peritoneum. (D) Continuous suture of peritoneum.

A fold of gauze is spread out under the edges of the wound and over the exposed intestines in order to protect the latter during the introduction of the continuous suture uniting the peritoneal incision (*Fig.* 294); this is gently withdrawn when the suture is nearly completed, and the opening in great part closed. The muscular layer is then closed in its turn by a second continuous suture, or better still, because the muscles do not hold the sutures well, by a series of U-loop sutures including both muscle and the overlying aponeurosis in their grasp, introduced as shown in *Fig.* 295. Finally, a continuous suture of the aponeurosis (*Fig.* 296) and closure of the skin wound completes the work.

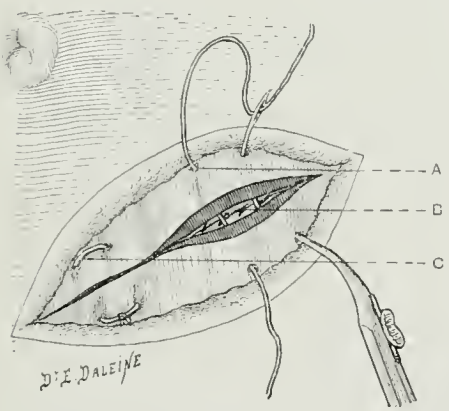


Fig. 295.—Wound of abdomen with omental protrusion. (A) U-Loop suture approximating the two edges of the musculo-aponeurotic layer. (B) Peritoneal suture. (C) U-Loop suture already tied.

2. **Primary Median Laparotomy.**—Although a lateral laparotomy at the site of injury gives satisfactory access in operating on a thin subject, when the wall is thick and fat it is better, and permits of more rapid working, to make the incision in the middle line—at least after local exploration has demonstrated the presence of serious deep lesions.

Median laparotomy is also required as the primary step when *multiple*

parietal wounds are present. Of course each of the wounds will be carefully cleansed and, if necessary, sutured.

It is always of importance to make the abdominal incision *sufficiently large :* the necessary intra-peritoneal manipulations can be carried out more expeditiously, more easily, and with greater safety when the operator gives himself plenty of room.

If the incision has been made at the site of injury, a careful preliminary investigation of the underlying area must be carried out with the least possible disturbance of the visceral relationships, the surgeon contenting himself with swabbing up the blood and extravasated blood, and very gently retracting the omentum and the nearest coils of intestine. Very often the lesions will be found during the course of this primary search. If median laparotomy has been preferred, attention must be immediately directed, after opening the peritoneum, to the area, or various areas of injury if they are multiple, aseptic compresses being arranged to cover and protect the uncontaminated coils, making as far as possible a covered way to the seat of injury.

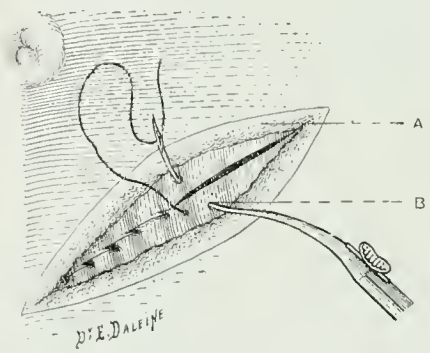


Fig. 296.—Wound of the abdomen with omental protrusion. (A) Skin and subcutaneous fat. (B) Continuous suture of the aponeurosis.

In dealing with lesions of the type which we are considering, the systematic examination of the abdominal contents already described is much more rarely required than in cases of abdominal contusion or of gunshot wounds.

Here, as before, any reparative measures required (mesenteric or intestinal suture, omental resection, etc.) must always be performed *outside the abdomen*, with the operation field carefully surrounded and isolated by gauze compresses.

The technique to be followed is identical with that described when speaking of lacerations of omentum, mesentery and intestine ; further on we shall study some other forms of intestinal lesions. One important difference between contused or lacerated wounds and stab wounds requires notice, the clean-cut wounds in the latter class less often necessitate any large resection of the margins and greatly simplify the work of repair ; intestinal resection followed by enterorrhaphy is therefore quite an exceptional necessity.

Finally, when performing a *late* operation on a case in which thirty-six to forty-eight hours or more have elapsed since the occurrence, the incision should be made at the seat of injury, and the greatest care exercised to avoid breaking down protective adhesions if any exist, and to preserve if possible the advantages of a localized lesion.

II.—LARGE WOUNDS.

Such wounds are produced by a very broad blade or by an instrument which has not only stabbed but also been used with a cutting action. Injuries caused by the horns of an animal are often of enormous size.

The characteristic feature of wounds of this type is the immediate protrusion of some portion of the abdominal contents. It is useful to study these extensive wounds associated with visceral protrusions at two periods: First, when they are quite recent; and secondly, when they are several hours or even a day or two old, and symptoms of secondary inflammation are present.

The surgeon is called to see a man who has just been gored by a bull: through a huge lacerated flap-wound of the abdominal wall a large mass of

Fig. 297.—Application of the abdominal binder after a laparotomy. First step.

intestines is prolapsed; it will be fortunate indeed if the wounded man in his efforts to reach a shelter is not found to have seriously aggravated his condition, and if he has had the presence of mind to support his abdomen with his hands. What is to be done?

Before anything else, wash and disinfect the abdominal wall and the protruding visceral mass: the preparation of the wall is carried out according to the usual method: the cleansing of the omentum and intestine by washing with warm boiled salt solution. This cleansing of the viscera is the most important step in the whole operation; no superficial hurried washing will suffice, for the patient's recovery to a large extent depends on the thoroughness with which it is done. Although unexpected recovery has sometimes succeeded upon hurried reposition without any

proper cleansing, still such cases are quite exceptional,[1] and in no way invalidate the rule.

Therefore devote the greatest attention to cleansing with gauze and warm water the coils of intestine, the omentum, and the mesentery, which under this treatment speedily assume a better appearance and a more natural colour and tonicity; continue the washing all around the pedicle of the protruding mass and on to the inner surface of the edges of the parietal wound. Not until this step has been satisfactorily completed should reduction be undertaken.

Until now I have assumed that the condition is not complicated by any lesions of the eviscerated organs. If there is any wound of the intestine, or of the mesentery or omentum, the surgeon will naturally begin by dealing with it, taking advantage of the evisceration to do what is necessary outside the abdominal cavity and adapting his technique to the needs of the case.

Fig. 298.—Application of the abdominal binder. Second step.

All attempts at reduction must be made methodically. Often it will be necessary to begin by enlarging the wound; this step is absolutely essential if the least difficulty is met with.[2] Slip the finger into the abdomen, first at one, then at the other, angle of the wound, and on it as a guide divide the wall with the scissors; at once secure with forceps the peritoneal edges all along both sides of the enlarged wound. By drawing the parietal peritoneum thus secured in an outward direction a sort of *serous funnel* is made, the smooth surfaces of which greatly facilitate the reduction of the intestines.

[1] Several such cases are to be found in the older literature, which would be almost incredible did we not know that in some individuals the resisting powers of the peritoneum are marvellously great, resembling those possessed by certain animals.

[2] It was necessary in a case of extensive traumatic evisceration, reported by Reboul. A little girl, 4 years of age, in falling on a piece of glass bottle, produced a large wound in the left flank, through which almost the whole of the intestines immediately escaped. Operation was undertaken an hour and a half after the accident: the eviscerated mass then comprised the greater part of the small intestine, the omentum, and portions of the colon and stomach; the viscera were congested, discoloured, bound together by whitish filamentous adhesions, and contaminated with earth and small bits of glass; they were cleansed with cotton-wool swabs moistened with a warm weak solution of sublimate; then an attempt at reduction under a large compress was made without success, the viscera being strangled by the lips of the wound. The wound was therefore enlarged upwards and downwards; reduction was then effected and the wound completely closed. The child recovered and was out of bed in three weeks. (Reboul. "Plaie pénétrante de l'abdomen par tesson de bouteille, etc." *Congrès de chir.*, 21 octobre. 1896.)

Do not attempt to reduce the herniated mass by ill-regulated pressure; this will but damage the viscera and fail to attain the object in view. A single loop which has slipped through a small wound may be reduced by taxis properly applied; but in the case of a large wound with extensive evisceration, it is necessary to proceed in a different manner.

Fig. 299.—Application of the abdominal binder. Third step.

Spread a large aseptic compress or towel over the protruding mass, tuck its margins carefully under the edges of the wound, then with both hands widely extended and applied to the surface of the mass, outside the compress, press steadily on it, while the tips of the fingers on guard at the periphery arrest and push back any loops which tend to escape. If a competent assistant is present, he will first retract and then raise the edges of the wound as the mass slips back under the pressure of the hands. Once reduction is obtained, leave the

Fig. 300.—The abdominal binder applied. Double vertical row of pins. Thigh bands.

compress in place—secured by a pair of pressure-forceps—during the first stages of closing the wound.

Here, again, the indications for drainage must be based on the amount of oozing which persists and the extent of the peritoneal contamination

by intestinal contents: in these cases, and because of the evisceration, the general cavity remains uncontaminated much more often than after ruptures or gunshot wounds: and provided that any solutions of continuity are properly sutured and the herniated mass is carefully cleansed, there is no reason why the abdomen should not be completely closed.

The suturing of the wound demands the greatest care, otherwise the accident will be complicated by adhesion of the viscera to the abdominal wall, which will probably give rise in the future not only to persistent pain, but also to intestinal obstruction, more or less complete, from bands or angulation.

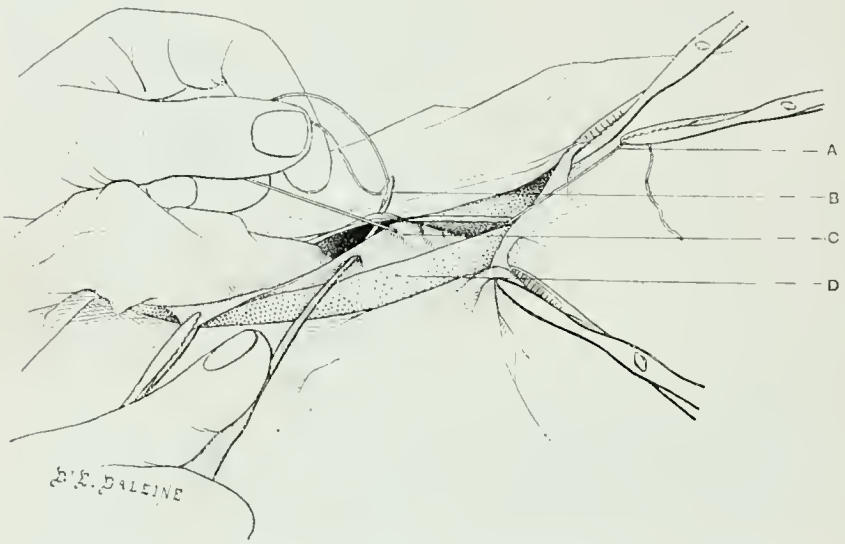


Fig. 301.—Suture of the abdominal wall. The deep layer. (A) Starting point of the deep continuous suture. (B) The needle picking up the two peritoneal edges. (C) Peritoneum. (D) Superficial aponeurotic layer. On the other edge of the wound, the middle layer, the rectus muscle, is seen under the aponeurosis.

I have seen a young man die of such conditions: the intestine was adherent to the wall of an enormous traumatic hernia, the loops were constricted and bound together by omental bands, and at the operation, which was undertaken at a very late stage—as the patient had not come into hospital until the third day—at a time when he was already seriously infected and almost pulseless, the bowel was found to be gangrenous. On several occasions I have had to operate for the cure of these ventral herniæ of traumatic origin; the work always presents very serious difficulties owing to the dense adhesions between the intestine and the wall of the false sac.

To obtain a good result the wound must be closed in *three layers* (*Fig.* 301), and sufficient time must be devoted to the task if it is to be done properly. This rule applies equally to the suture of the abdominal wall after all emergency laparotomies.

The *two peritoneal edges* with the fascia transversalis are closed by a *first continuous suture*; use fine catgut and a fine needle; introduce the

thread close to the free border and tighten the stitches gently to avoid risk of tearing the tissues. When the abdomen is flat and the walls are flaccid the peritoneal suture is very easily executed; but when the walls are distended, the tightly stretched serous membrane sometimes tears very readily under the traction of the thread: it is then necessary to include the muscular layer in the grasp of the suture.

The *second continuous suture* is applied to *the muscular layer* (*Fig.* 302). After a median laparotomy it brings the internal borders of the two recti muscles together and is passed through the whole thickness of the muscles; it is best introduced as an ascending suture, beginning at the lower end of the incision just above the pubes, where the two muscles lie close together.

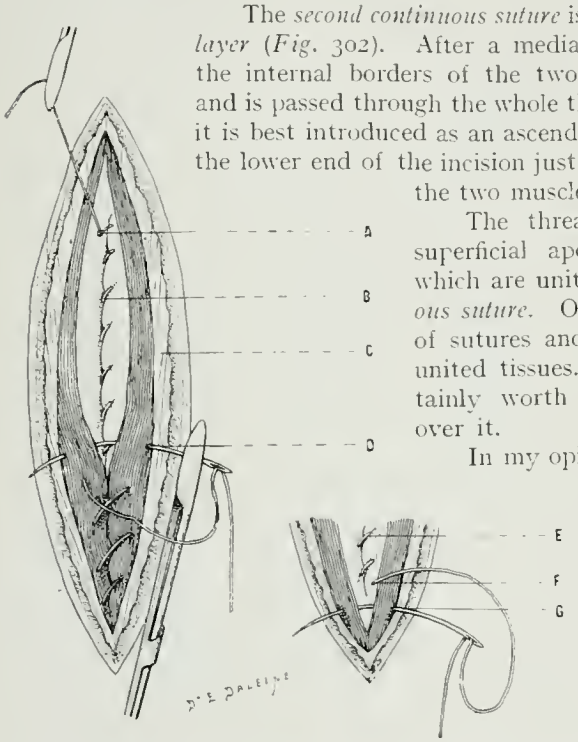


Fig. 302.—Suture of the abdominal wall. The muscular layer. (A) Starting point of the deep continuous suture. (B) The deep continuous suture uniting the peritoneal edges. (C) The aponeurosis. (D) Suturing the two recti muscles. (E) The terminal turns of the deep suture. (F) The thread passing from the peritoneal layer to the muscular layer. (G) Starting point of the continuous suture uniting the muscles.

The thread then passes to the superficial aponeurosis, the edges of which are united by the *third continuous suture*. One has now three rows of sutures and three layers of firmly united tissues. Such a result is certainly worth the extra time spent over it.

In my opinion this is the method of choice: but if it is necessary to get the operation finished very quickly, or if the wall is thin and tense, peritoneum, muscles, and aponeurosis may be united by a common ascending continuous suture (*Fig.* 303), and then using the same thread, the edges of the aponeurosis will be adjusted by a second continuous suture introduced from above downwards (*Fig.* 304): or again, the wound may be closed by a series of interrupted sutures including the skin and the whole thickness of the walls on either side.

Finally, I wish to say that satisfactory repair of the damaged abdominal wall is one of the important objects of the practical rule which we laid down at the beginning.

In every case of abdominal wound make a direct examination, even in the absence of any symptoms, for the purpose of disinfecting and repairing the wall if nothing else is required.

Treatment will naturally be modified somewhat when the traumatic

rupture is no longer recent, and the omentum and intestine have remained for some hours, perhaps even for one or two days, in contact with a more or less doubtful dressing. One or other of two conditions may then be presented:

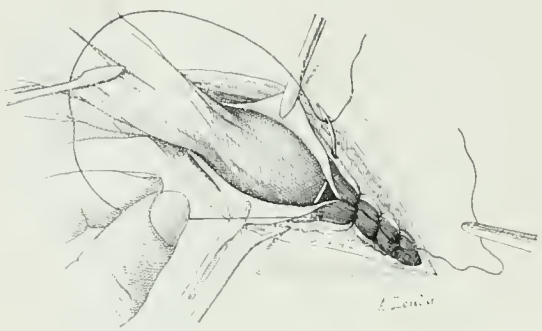


Fig. 303.—Suture of the abdominal wall. Uniting the peritoneal and musculo-aponeurotic layers by a single continuous ascending suture.

(*a*). **The accident is still comparatively recent; the protruding intestine is uninjured,** and is attached to the lips of the wound merely by soft adhesions.

In such circumstances nothing prevents secondary reduction. The herniated mass is first of all carefully washed with warm boiled saline solution, then the adhesions are separated, the wound is enlarged and, by drawing the mass a little farther out, the pedicle and its surroundings are properly disinfected before reduction is begun. If there is any doubt, the wound will be only partly closed and a drainage tube left in the abdominal cavity.

When there exist *one or more wounds of the eviscerated intestine*, the local condition is usually much less favourable for such methods. However, if no serious inflammatory lesions have developed, particularly if there is no diffuse peritonitis, reduction may be carried out as before, after repair of the visceral wounds and thorough cleansing.[1] Of course under such circumstances drainage is essential.

Fig. 304.—Continuous descending suture of the aponeurosis.

(*b*). **The accident is comparatively old.**—The appearance of the protruding mass is bad, it is discoloured and gangrenous in places, perforated by purulent tracks, and the constituent loops are glued together by lymph and false membrane. To

[1] Most unexpected recoveries are sometimes obtained. Take, for example, the case reported to the Société de chirurgie in March, 1899, by MM. Reynier and Thiéry. A man of 22 years had received several knife stabs in the lumbar region through which the intestine had escaped. Operation was undertaken four hours later: "In the left lumbar region a vertical wound between four and five inches long, extending from the costal margin to the iliac crest, was found. From the wound about four feet of small intestine protruded. The intestine was red, congested, and soiled with dirt and fragments of clothing. Closer examination showed five perforations, two being almost complete hemisections, and three simple perforations placed at irregular intervals. M. Thiéry, after carefully cleansing the wound and intestine with warm boiled water, sutured the perforations, reduced the intestine, and closed the wound, leaving in a strip of sterilized gauze. Recovery." (*Bull. de la Soc. de chir.*, 1899, p. 231.)

reduce the intestine in such a condition would be foolish; under these circumstances, which are fortunately exceptional, it is best to leave things alone, to content oneself with a short enlargement of the wound, if required to relieve constriction, and with covering the mass with moist aseptic compresses which must be frequently changed.[1] Subsequently, if the patient survives, the lesions may be dealt with as their condition requires.

III—GUNSHOT WOUNDS.

The day of theoretical discussions and systems of treatment is past. Apart from contingencies dependent on time and place, there is only one rational method of dealing with these injuries, a method based on definite principles and which we should use every endeavour to bring into general practice. The surgery of probabilities and statistics belongs to a bygone age; its methods may still be the only methods applicable under certain circumstances, but they are not and never have been anything better than makeshifts—methods of necessity, not of choice. At a time when the gravity of an abdominal operation was almost equal to that of the injury, there was good reason for abstention except in conditions of extreme urgency: the question then was simply this, Is it not better for the patient to take the chance of spontaneous recovery than incur the dangers of operation? The question may still be put in the same words when the surroundings and conditions are such that the dangers of operation become as great as formerly.[2]

Now, however, the conditions have changed: formerly, abstention was the rule because of the great responsibility associated with an operation in itself only too often fatal; to-day, operation, and operation at the earliest possible moment, is the rule if we wish to avoid the responsibility of refusing the patient his best chance of recovery. **It is prudence which demands early operation.**

Without entering into theories and experiences, I ask simply this: Are there many surgeons at the present day who, knowing of the certain or even probable existence of an intestinal wound would advise against operation? I know perfectly well that cicatrization of intestinal perforations has been demonstrated at post-mortem examinations performed long after the injury; I know also that rapidly formed adhesions or the

[1] Large eviscerated intestinal masses have been known to gradually recover and to be spontaneously reduced when the patient has escaped septic complications in the early stages.

[2] And according to the experiences in the South African and Russo-Japanese wars, the answer must be in the affirmative for military practice in the field; laparotomy for abdominal wounds caused by rifle bullets was attended by a very considerable mortality, which contrasts very remarkably with the high percentage of recoveries in the non-operated cases. But it must be remembered that the conditions under which the operations were performed are scarcely comparable to those which obtain in time of peace. Further, it has been shown that the ball of a modern military rifle, owing to its hard envelope, its small calibre, and its great penetrative force, produces visceral lesions with very special characteristics, which are often benign, and capable of spontaneous repair. In fact no conclusions applicable to gunshot wounds caused by "civil" weapons can be drawn from military experiences.

application of a neighbouring loop, not to speak of the famous mucous plug —septic by the way—may serve to temporarily close the wound, prevent fæcal extravasation, and may become the agents of permanent healing. But I ask again, Can we conscientiously tempt fortune in such a manner? And can we feel the same confidence in the chances of an exceptional process as in an early operation, properly performed under aseptic conditions?

The answers to these questions are clear. In all times the true surgical spirit—the surgical instinct—has rebelled against the doctrine of *laisser faire* or "wait and see." As soon as it is admitted—and the fact has been well and repeatedly demonstrated to us—that a penetrating wound of the abdomen and intestinal perforation are synonymous, the indications become definite, simple, and indisputable; the patient has probably some chances of spontaneous recovery, but there is no standard whereby those chances can be estimated even in the apparently most favourable cases: by waiting a few hours infection will be established; it will extend steadily and insidiously, every instant reducing the probability of the success of a delayed operation.

At the present day need we submit to such uncertainty? Are we compelled to accept this responsibility of so-called armed expectancy, a responsibility far heavier than that of an early laparotomy properly performed?

These operations are difficult and dangerous, it is true: the perforations are often multiple: eight, ten, twelve, eighteen and more have been seen; it has happened to the best operators to overlook some. All these points prove nothing against the doctrine of early intervention; can we suppose that spontaneous recovery was possible for these unfortunates whose intestines had been perforated at twelve or more different points? Is it conceivable that the process of natural obliteration could close twelve or eighteen perforations?

We must simply recognize that these are very serious cases, indeed, almost hopeless, but in which operation offers the only chance of recovery. Besides, one cannot know in advance what lesions will be met with, or whether, instead of it being one of these desperate cases, only one or two small perforations may be found, easily accessible and easily closed. What will the feelings of the surgeon be if, owing to unnecessary delay, he at the same time finds generalized peritonitis; or, if at the autopsy he is compelled to recognize that a little initiative in the early stages would have saved the patient!

The clinical possibilities may be divided into three groups: (1) **Those in which the gravity of the lesions is evident from the first**; (2) **The doubtful cases**; (3) **The cases which are very probably benign.**

1. **The Gravity of the Lesions is evident from the first.**—Of course the escape of flatus or fæcal material, or abundant hæmorrhage from the wound, are exceptional symptoms, not as a general rule to be

expected. But the general and local conditions of the patient are sometimes from the outset perfectly characteristic: the pulse is feeble, the face rapidly becomes drawn and pinched, the abdomen becomes distended, the wall is rigid, *resisting and defending itself* against the lightest pressure, dullness appears in the iliac fossæ, resonance in the hepatic region, vomiting[1] comes on and continues. The persistence and steady advance of these symptoms during the first few hours are amply sufficient to destroy any illusions as to the gravity of the case. Nothing is to be gained by waiting: the situation is only too definite; do not look for fresh indications, but operate as soon as possible.

We may add that **the single fact of multiplicity of the wounds**, apart from any urgent symptoms, ought to be considered from the first as an absolute indication of the need for immediate operation. When a man has received two or three revolver bullets in his abdomen it is quite unnecessary to ask for any further information. Here again the diagnosis need not occupy the surgeon's thoughts: he ought to devote all his attention to preparing for the operation, in order that he may do it in the best possible manner under the conditions in which he is placed.

When the accident occurred one or two days previously and one is summoned only at a late stage, one or other of the two following possibilities may be met with:—

(*a*). The internal lesions express themselves by evident signs of peritonitis, more or less advanced; again, operation must be undertaken if there is still time. (See later. DIFFUSE PERITONITIS.)

(*b*). No bad symptoms have developed; the initial shock has disappeared, the pulse is good; there has been no vomiting; there is no abdominal tenderness or distention; the bowels have acted, and flatus has been passed: it will then be quite justifiable to accept the promises of these favourable signs and to await their confirmation, at the same time exercising the closest supervision and instituting the ordinary measures of expectant treatment (ice to the abdomen, opium, rest in bed, and absolutely restricted diet). As a matter of fact, if the wound is actually penetrating, we know too well how deceptive this apparent benignity may be, and we have had sad experience of the insidious development, and the sudden unexpected outbursts, of peritoneal infection.

2. **The Doubtful Cases.**—Here we have a different state of affairs. We have been called in immediately after, or within a few hours of, the accident, and find at one or other point on the anterior abdominal wall the round and blackened hole made by the bullet, but nothing more. The pulse is good, the abdomen flat; there is no definite sign. What is to be

[1] The vomiting of blood—either pure, or more frequently blackish, and mixed with gastric contents—is an almost certain proof that the stomach is injured, although it has been very exceptionally observed subsequent to wounds situated high up in the intestine, and even where the alimentary canal has not been injured by the projectile. (SCHRÖTER, Einiges über Schussverletzungen des Magens. *Arch. f. klin. Chir.*, 1895. Bd. li., i., p. 169.) Epigastric pain, often very severe, is felt in cases of gastric wounds.

done ? Shall we wait a few hours, keeping the patient under close and attentive observation and ready to intervene at the first indication ? This practice, it must be admitted, is almost always followed ; it has the danger of being too elastic and its limits too indefinite.

What is the first sign to be ? The enfeeblement or increasing frequency of the pulse, commencing distention of the abdomen, alteration in the face : these alterations, after all, are not easily defined in the early stages ; they convey impressions rather than indications.

Is it not better to answer the question resolutely in these terms : **let us make sure first of all whether the wound is actually penetrating ; if it is really so, then let us perform laparotomy at once,** at least if we are in a position to do it properly and to reduce the risk of the operation to its proper minimum. Acting on these lines we shall doubtless operate on some cases which would have recovered spontaneously ; but will they make any less satisfactory recovery because of the operation ? And in contrast to these occasional cases in which operation will have been, not harmful, but perhaps unnecessary, there are so many others where, thus performed in good time, operation will reveal unexpected lesions[1] and insure recovery.

Moreover, altogether apart from any intestinal perforation, a penetrating bullet may produce conditions associated with grave danger to the patient, and, further, the risk of peritoneal infection is always present. Take the following example :—

Case 24.—A young soldier was brought one morning to La Pitié ; some hours previously he had fired a revolver shot at the pit of his stomach, and we found on the right side of the epigastric region a circular blackened orifice from which there was no discharge of any kind. Immediately around the wound pressure caused a little pain, but the rest of the abdomen was soft and insensitive ; there had been no vomiting, the pulse was strong and practically normal, and, apart from great nervous excitement, the general condition was perfectly satisfactory.

The treatment was limited to cleansing and closing the small external wound, applying an ice-bag to the abdomen, and the administration of opium. The remainder of the day passed without incident ; next morning *the pulse was a little quicker and the face less satisfactory* ; in the afternoon the patient *vomited* for the first time, the vomit being greenish bilious material ; the temperature was 100·8. Laparotomy was performed at 4 o'clock, the incision being made above the umbilicus.

We came down at once on blood-stained omentum, covered with clot and loosely adhering to the abdominal wall ; the omentum was raised, and we then found that it had been lacerated and bruised in its lower left portion by the

[1] Lesions of the intestine or stomach, or lesions of neighbouring organs. These complications occur very frequently in cases of gunshot wounds, particularly those which affect the epigastric zone (wounds of the liver, spleen, pancreas, kidney, great omentum, etc.). Schröter (*loc. cit.*), in 32 cases of laparotomy for gunshot wounds of the stomach, found 6 uncomplicated and 26 complicated ; the results of operation are interesting. In the 6 uncomplicated cases there were 4 recoveries and 2 deaths ; in 5 of the 6 cases the operation was performed in less than six hours and in one case six hours after the receipt of the injury. The 26 complicated wounds gave 10 recoveries and 16 deaths ; in 10 the operation was performed less than six hours after the injury (7 recoveries, 3 deaths) ; in other 10 more than six hours after (2 recoveries, 8 deaths) ; in 6 the time between the accident and operation is not stated (1 recovery, 5 deaths). Although surgical statistics are too often of doubtful value, those which we have just quoted speak too definitely in favour of early operation to be misconstrued.

bullet. The injured segment was resected after the application of chain ligatures. The small intestine appeared perfectly normal, and no blood, no suspicious fluid, no sign of injury, was found in any other part of the abdomen. The wound was closed and an uneventful recovery followed

The above case, therefore, shows that the omentum alone had been injured by the projectile, but commencing infection had expressed itself by unmistakable symptoms, which fortunately were observed and combated in time.

But would it not have been better to have operated at once, basing the indications on the single fact of penetration with its consequent almost inevitable lesions, lesions which are always serious and of doubtful issue, even when the intestine has been spared ?

Therefore the wise practice—when equipped and furnished with everything essential for carrying it out—appears to me to be the following :— Before any exploration, begin by preparing the wounded region ; then enlarge the wound of entry upwards and downwards, incising the skin and underlying planes of tissue step by step, and carefully inspect the bottom of the parietal wound.

If the peritoneum is intact the wound can be carefully sutured in layers, after excising the contused and blackened margins of the bullet track, and an absolutely favourable prognosis may at once be given.

If the peritoneum is perforated, enlarging the opening a little will always furnish some information as to the nature of the intra-abdominal lesions. One may see blood, sometimes intestinal contents, or bile or urine, escape. But even in the absence of such definite indications, immediate laparotomy is rendered necessary by the single fact of proved penetration, and the abdomen will be opened in the middle line.

Although in cases of injuries produced by cutting and stabbing instruments, lateral laparotomy at the site of the primary wound sometimes gives adequate access, it is always better when dealing with gunshot wounds **to have recourse at once to median laparotomy.**

This will be performed at the level of the parietal perforation, above the umbilicus, in gunshot wounds of the epigastric zone ; below, when the bullet has entered in the flank, the iliac fossa, or the hypogastric region. There is often no correspondence between the parietal wound and the deep lesions, and when the bullet has traversed the peritoneal cavity obliquely, the perforations are very often multiple and widely separated ; it is none the less advisable always to begin the exploration by examining the zone of entry and enlarging the track if any special reason for doing so should present itself.

Here, as in the other abdominal conditions already discussed, the first steps of the intra-peritoneal examination ought always to be conducted with the viscera *in situ*. After the abdomen is opened, and with the edges of the incision widely retracted, you must *look* before doing anything else, and endeavour to discover some indication—a blood track, etc—which will conduct you to the deep focus of injury ; all this can be done very quickly ; it loses no time and may gain much.

In the case of a wound of the stomach (*Fig.* 305) it is always necessary to explore the posterior surface of the organ and to seek for a second orifice, the wound of exit, which is often very difficult to find and close, and has many times been overlooked with fatal results. To carry out this investigation, as soon as the wound of entry is sutured (*Fig.* 306) an opening is made through the great omentum, close to its attachment to the great curvature of the stomach, in an area free from large vessels; access is thus gained to the lesser sac of peritoneum (*Fig.* 307), from which there is often a considerable escape of blood, gastric contents, or pus; the rest of the abdominal

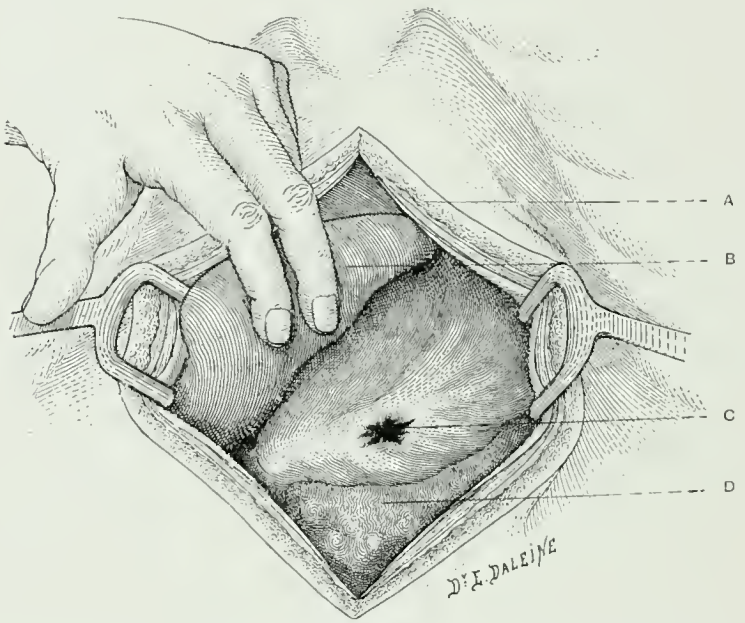


Fig. 305.—Bullet wound of stomach. The wound of entry on the anterior surface, close to the greater curvature. (A) Abdominal wall. (B) Liver border raised. (C) The bullet wound with lacerated edges. (D) Great omentum.

cavity must therefore be shut off by carefully arranged gauze compresses before the opening is made in the great omentum. After any discharge has been wiped up, the lower border of the stomach is gently raised, and its posterior wall systematically examined from below upwards; the perforation may be recognized with the finger; but to suture it, it must be seen. If that is impossible, it is better to lightly pack and drain the lesser sac than to attempt blindly to close the opening.

In these cases, more decidedly even than in the contusions, the abdomen must never be closed until a minute and systematic examination has been made in the manner we have already described. This may be an exceedingly troublesome undertaking under any circumstances, but it is always particularly difficult in late operations where, owing to the

commencing peritonitis, the intestines are distended and glued together by inflammatory exudate.[1]

Complete primary evisceration[2] is—in some hands—an excellent method: through a very long median incision the whole mass of intestines is allowed to escape and is immediately enveloped in large aseptic towels, wrung out of warm sterile water. The various lesions are then easily found, and, if serious hæmorrhage is going on, the abdominal aorta can be compressed by an assistant during the course of the exploration; the damaged loops are kept outside under protecting compresses while the rest

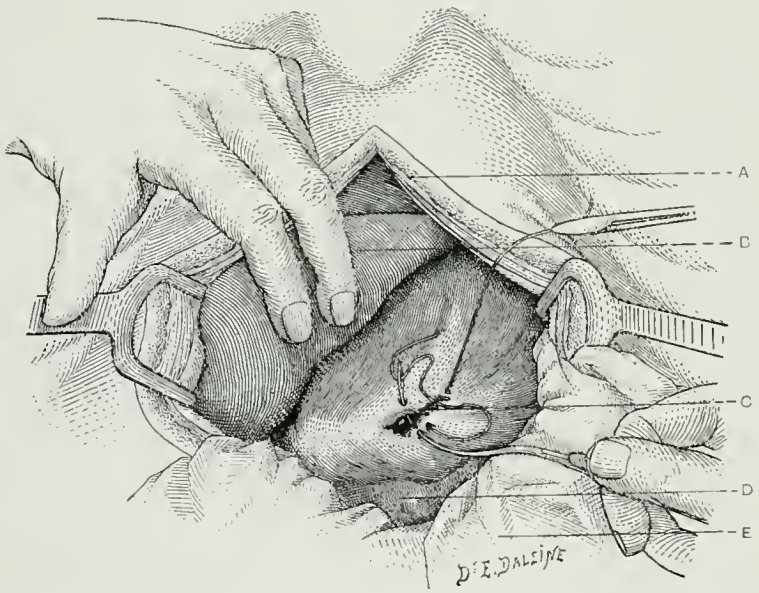


Fig. 306.—Bullet wound of stomach. Suturing the anterior perforation. (A) Abdominal wall. (B) Liver border raised. (C) Suturing the perforation: First suture, including all coats; it will, of course, be buried by a second broad sero-serous suture. (D) Great omentum. (E) Protecting gauze compresses.

of the intestines are replaced in the abdomen. The various perforations are then sutured, each loop, after repair, being carefully cleansed and replaced.

Thus performed as a predetermined primary step, complete evisceration saves a great deal of time and permits of a very thorough examination being made.[3] Of course in late operations, when the intestines are dis-

[1] Those terrible and universally dreaded operations which last from two to perhaps four hours, and in the course of which some one or more perforations are overlooked, have been for the most part late operations performed under the compulsion of peritonitic symptoms after a longer or shorter period of expectant treatment.

[2] See a very complete study of the subject in Louis Tixier's thesis: *Pratique de l'éviscération en chirurgie abdominale. Du shock abdominal.* Thèse de Lyon, 1897.

[3] It has enabled William Bull to suture seven wounds of the small intestine, Hamilton to ligature a mesenteric artery, to close eleven wounds of the small intestine and two of the colon. The patients recovered (quoted by Louis Tixier, *loc. cit.*). Albarran employed it with equal

tended and the patient's general condition bad, it is too dangerous to be attempted.

In the suture of perforations of varying extent and shape, the technique already described will be followed. (See also CONTUSIONS OF THE ABDOMEN.) The resection of a wounded loop, the seat of multiple close-set perforations,[1] is here again indicated, and will be followed by occlusion of the two ends and lateral anastomosis. In the case of a boy, 11 years of age, a revolver bullet of 7 mm. calibre had penetrated below and to the left of the umbilicus;

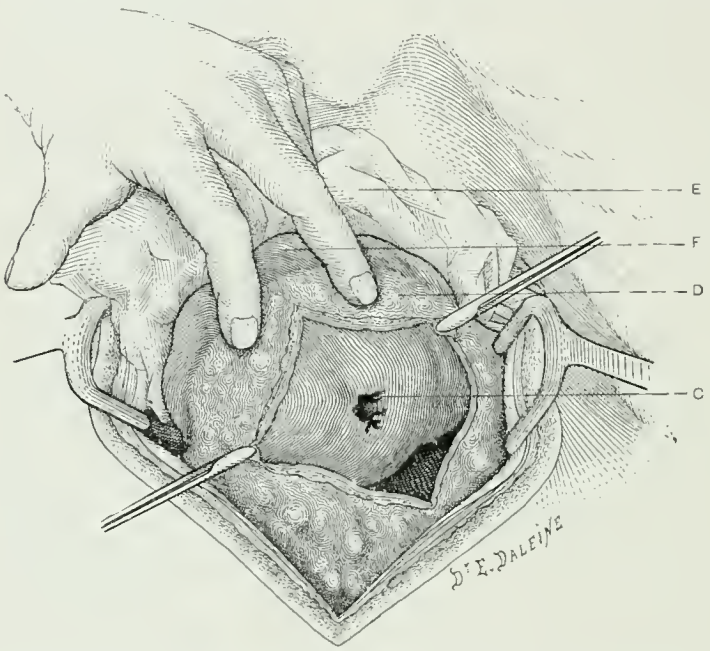


Fig. 307.—Bullet wound of stomach. Exposure of the posterior perforation. (C) Wound of exit on the posterior wall. (D) Gastro-colic omentum in which an opening has been made to obtain access to the posterior surface of the stomach. (E) Protecting compresses. (F) Great curvature of the stomach turned so as to expose the posterior surface of the organ.

operation was performed four hours after the accident; twelve perforations situated near the junction of the jejunum and ileum were found; the two most distant were closed separately, and a loop twenty inches long, which bore the remaining ten, was resected and a lateral anastomosis made. Neither peritoneal lavage nor drainage. Recovery.[2]

success in the case of a pregnant woman who had received a revolver bullet in the abdomen: he operated five hours after the occurrence, practised immediate evisceration of almost the whole intestine, protecting it with a warm moist towel, and found four wounds of the upper third of the small gut and a perforation of the uterus. Suture. Recovery. ("Plaies multiples de l'intestin et de l'utérus gravide par balle de revolver. Procidence du cordon dans le ventre de la mère. Laparotomie. Guérison." *Soc. de chir.*, 27 mars, 1895. See later: WOUNDS AND RUPTURES OF THE UTERUS.)

[1] These multiple perforations caused by a single bullet are usually situated on a comparatively short length of intestine.

[2] FRANCKE, "Zur Casuistik der vielfachen Schussverletzung des Dünndarms." *Arch. f. klin. Chir.*, 1902, Bd. lxvi., p. 858.

In the case of a patient of M. Sourdat there were also twelve perforations in the small intestine; six were sutured, the others occupied an intestinal segment about fourteen inches in length, which was resected (*Fig.* 308): the two ends were joined by lateral anastomosis. Recovery ensued without any difficulty.[1]

3. **Cases which are probably Benign.**—The procedures described above are in our opinion judicious and advisable in the case of penetrating wounds inflicted by bullets of some calibre and endowed with a fairly considerable penetrative force.

Naturally, they cannot be applied generally to all gunshot wounds of the abdomen, because amongst them are some which are never practically associated with serious lesions, and which are quite evidently curable by the natural powers alone; I refer to those caused by small pistols and miniature rifles, the bullets of which, 4 to 5 mm. calibre, are propelled by *exceedingly small charges of powder* and expend their force in traversing the wall; or, again, to those produced by *small shot fired at a considerable distance.*

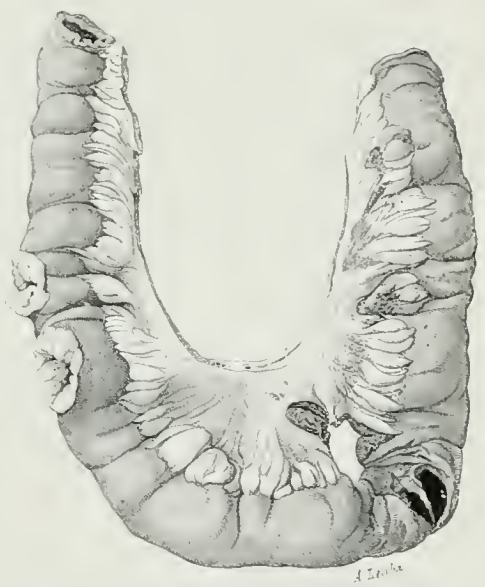


Fig. 308.—Loop of small intestine with multiple perforations, due to bullet wound of the abdomen, and resected.

The perforations thus produced, if any, are so small that any leakage of intestinal contents is prevented by the contraction of the muscular coat, speedily reinforced by peritoneal adhesions. This applies particularly to the epigastric zone, for it has long been known that the stomach is particularly well adapted for the spontaneous occlusion of small perforations because of the thickness of its wall.

It may even happen that these small projectiles may traverse the abdominal cavity from side to side without producing any lesions of importance, or at least which express themselves by the slightest symptom.

I have had under my care a boy who had received a small bullet in the abdomen from a toy rifle while playing with a friend; there was some tenderness around the tiny wound, but the rest of the abdomen was soft and insensitive; there was not the slightest indication of any visceral lesion

[1] Sourdat, "Les perforations multiples de l'intestin par plaies d'armes à feu." *Revue de chir.*, déc., 1908.

and no reason for interference. No symptoms developed, and at the end of a week the patient was allowed up. However, a radiographic examination demonstrated that the little bullet was embedded in the mass of the erector spinæ muscle, and the position of the wound of entry, close to the middle line in front, rendered it very improbable that the projectile had passed round in the abdominal wall.

In cases of this kind there is of course nothing to be done; still it will be well to be cautious and to exercise close supervision for a sufficient time.

INJURIES OF THE RIGHT HYPOCHONDRIUM. WOUNDS AND RUPTURES OF THE LIVER AND OF THE BILIARY PASSAGES.

Death after a wound of the liver is due either to *hæmorrhage* or *infection*, most frequently the former; hæmorrhage is indeed the great danger of these injuries, an immediate danger arising from such serious lesions that a fatal result can only be averted by early and rapid operation.

The last statement needs no demonstration; any one who has seen a rupture of the liver, bleeding, will be convinced of the utter uselessness of any other measures and of the crushing responsibility assumed in refusing or delaying an operation, difficult and dangerous it is true, but which represents the only possible chance of recovery.

I.—THE INDICATIONS FOR OPERATION.

1. **In Contusions and Ruptures.**—After a contusion the fundamental indication is furnished by the signs of **serious internal hæmorrhage.**

A man has been knocked down by a heavy wagon, one of the wheels of which has crushed him violently at the level of the right false ribs; he is unconscious when picked up, but gradually his senses return; one finds him very pale, his face and hands covered with a cold sweat, the pulse 120 to 130, very weak and soft; the temperature is subnormal, between 97° and 98°; respiration rapid, short, and laboured; palpation is painful over the whole surface of the abdomen, but particularly on the right side in the hepatic region, where the wall hardens and defends itself under the hand. While this examination is being made, and some brief enquiries as to the details of the accident, the pulse is evidently getting weaker, the dyspnœa becomes more marked, and forced respiratory efforts, sometimes convulsive gasps, add the last touches to the picture.

Do not look for any further reasons for action, and do not lose time in trying to complete the diagnosis by locating the lesion: **there is internal hæmorrhage; open the abdomen and deal with it directly.** The rule is apparently a rough one, but it corresponds to the exigencies of the situation.

At other times, though less profuse, the bleeding *by its persistence* produces an equally grave danger, and, after some hours, prescribes similar action. After violent injuries of this kind one must never trust—we have already and repeatedly emphasized this point—to the results of a single examination.

The patient, who is found recovered from the initial shock, apparently in a satisfactory condition, with a good pulse, respiration practically normal, and suffering very little pain, may after a variable interval pass into a state of progressive collapse, which is the more significant because its onset has been delayed, and it cannot therefore be ascribed to the direct effect of the injury; first appearances will often give a very erroneous idea of the gravity of the case, and if the next examination is deferred until the following day, this may expose the practitioner to a painful surprise.

Many times I have closely followed these successive stages of collapse and noted the march of symptoms, mere suspicions at first, but becoming more and more accentuated, which indicated the continuance of internal hæmorrhage.

The pulse is normal, the face is good, there are no definite indications: that is well. Wait, however, keeping the patient under close observation. Half an hour, an hour later, or perhaps later still, the situation has changed; the face has altered, the pulse has weakened, the temperature is subnormal, there is increasing dyspnœa, the abdomen is beginning to distend, the wall is rigid and resistant in the injured region; percussion sometimes detects subhepatic dullness or *dullness in the right iliac fossa*, indicative of the presence of effused blood. There can now be no doubt as to the condition of affairs; here again, **there is internal hæmorrhage, and operation is necessary.**

At a still later date the indications are fairly often supplied by the *signs of infection*, under which conditions the operative prognosis becomes much less favourable. It is particularly in the cases of **ruptures of the biliary passages,** without serious associated lesions of the liver and consequently without profuse bleeding, that the indications are furnished *secondarily* by symptoms of *peritoneal reaction*, often of localized peritonitis.

In the early stages, pain in the right hypochondrium and in the subhepatic zone, sometimes radiating to the right shoulder, some degree of distention of the abdomen, some dullness, perhaps rather indefinite, in the right iliac fossa, nausea and vomiting, constitute all the evident symptoms: there are no commanding indications, nothing even on which to base a probable diagnosis. It is only at a comparatively late date, varying according to the degree of septicity of the effused bile, that more or less serious peritonitic symptoms supervene.

Routier[1] has reported the case of a boy, aged 12 years, who had received a violent kick in the abdomen three days before coming under

[1] *Bull. de la Soc. de chir.*, 7 déc., 1892.

observation. At the time of the accident "he had felt acute pain, had lost consciousness, and had shortly afterwards vomited." On the third day, the abdomen "was uniformly distended and generally tender, more particularly in the subhepatic region: the tongue was dry, the pulse fast and small, the temperature elevated, and there was vomiting of bilious material." The boy was evidently suffering from peritonitis; but as flatus had been passed after his arrival in hospital, it was decided to wait. In three days the symptoms had so much improved that the child was taken home by his mother.

"Soon he was brought back, with pinched face and feeble pulse, and with the abdomen swollen and painful, and evidently containing a considerable quantity of free fluid. The abdomen was opened by an incision below the umbilicus, a little difficulty being experienced owing to the adhesion of loops of small intestine to the wall, and from the wound about three pints of bronze-green frothy fluid exactly like bile escaped. This fluid was diffused throughout the whole of the peritoneal cavity, but not uniformly; the chief accumulation was in the right flank—the seat of the injury—and was shut in by masses of lymph which hid the under surface of the liver and the ascending colon. It was impossible to discover the rupture in the bile passages, which was undoubtedly covered by masses of lymph and false membrane. There was no reaccumulation of the fluid, and recovery took place without complication."

Although the opinion has often been expressed that no primary intervention ought to be undertaken in these ruptures, but that encystment of the effused bile should be awaited, and although the recommendation is not unreasonable when the circumstances are such as to militate against the proper performance of operation, it is certainly much better not to incur the risks of a peritoneal reaction, the intensity of which cannot be foreseen, but to have recourse to operative measures as soon as there are sufficient indications of a serious lesion of the liver or the biliary passages.

2. **In Wounds produced by Sharp Instruments and Firearms.**—The problem presents itself under a somewhat different aspect in the case of a stab or gunshot wound. The mere existence of an open wound and the great probability of *infection* are quite sufficient reasons why immediate operation should be the method of choice even when other symptoms are apparently not serious. There are, however, certain practical distinctions to be made between the different varieties of these lesions.

If the case is one with a *small wound or a puncture*, do not forget the tolerance of the liver tissue for such injuries; if the pulse is good, the local pain very moderate, and no subhepatic zone of dullness is found, the immediate treatment should simply consist in the occlusion of the external wound, after disinfection, and the application of a broad flannel binder, well padded with cotton-wool, to the abdomen. The patient must of course be kept under close observation.

I once saw at La Pitié a man who had received two stabs with a narrow blade below the right false ribs; there was very little bleeding from the two small wounds, and there were no signs of internal hæmorrhage; the

pulse was strong, the abdomen soft, the face satisfactory, and some hours had elapsed since the accident. I therefore contented myself with the measures indicated above, and rapid healing ensued.

With a wound of some width, a knife-stab for instance, one can hardly count on such a fortunate outcome, and, besides, the character of the wound and the immediate symptoms often allow no room for hesitation from the first.

(*a*). You may meet with a **large wound with visceral protusion.** That was the case of one of Schlatter's patients.[1]

When leaving a tavern at 11 o'clock at night he had received a knife stab in the abdomen: he felt very little pain, but perceiving that his clothes were soaked with blood he betook himself on foot to the house of a medical man. He did not find the first doctor, and he continued to walk for half an hour while looking for another. When he arrived he was extremely pale, and the doctor found a wound with protruding intestine in the epigastrium. After a hasty dressing the patient was taken to the cantonal hospital. The abdomen and both lower limbs down to the toes were completely covered with dried blood; through the wound, about 8 inches of the transverse colon and a mass of omentum protruded.

The wound was enlarged, and *on the convex surface of the liver, near the attachment of the suspensory ligament, a wound* $\frac{3}{4}$ *inch long and penetrating to a depth of* 3 *inches was discovered.*

(*b*). **There is profuse hæmorrhage from the wound,** and the patient collapses so rapidly that there is scarcely time to do anything. However, it is to be remembered that apart from lesions of the great vessels at the hilum—the portal vein or its divisions, or the vena cava—hæmorrhage from the liver parenchyma, considerable though it may be, is rarely so quickly fatal as not to allow time for a rapidly executed operation.

(*c*). The wound is bleeding little or not at all, but the intense pallor, the feeble pulse, the respiratory distress, the subnormal temperature, indicate **internal hæmorrhage.**

Here again there can be no pretext for abstention. Even in the absence of characteristic initial symptoms it must not be concluded that there are no important lesions, and the wisest and safest attitude will always be to **consider penetration as a sufficient reason for immediate operation.**

In support of this view the following case of Dalton's reported by Terrier and Auvray[2] may be quoted: "A man, two hours before his admission to hospital, received a knife stab in the abdomen. His general condition was good, the temperature was 100°, the pulse 72, respirations 32, and he had no acute pain. Dalton operated, however, and found *two wounds of the liver* and *one of the stomach.*" The patient recovered.

Knife stabs or revolver bullets may wound the liver by different

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[1] Schlatter, "Die Behandlung der traumatischen Leberverletzungen." *Beitr. f. klin. Chir.*, 1896, Bd. xv., 11, p. 521.

[2] Terrier et Auvray, "Les traumatismes du foie et des voies biliaires." *Revue de Chirurgie*, 1896, p. 717, and 1897, p. 16.

routes: by way of the anterior abdominal wall most commonly, but also by the lateral hypochondriac region, and, exceptionally, by the posterior surface of the thorax.

It is rare in bullet wounds that there is much bleeding from the orifice of entry: the signs of *internal hæmorrhage at the outset*, and of *peritoneal reaction at a somewhat later stage*, furnish the indications for operation. And what we have just said with regard to wounds produced by sharp instruments applies equally here.

II.—THE TECHNIQUE OF OPERATION.

I assume that a probable diagnosis of wound or rupture of the liver has been made, and it has been decided to operate.

Everything is ready for laparotomy: the patient's limbs are enveloped in cotton wool, he has been revived by the injection of saline solution, and arrangements have been made for continuing the administration during

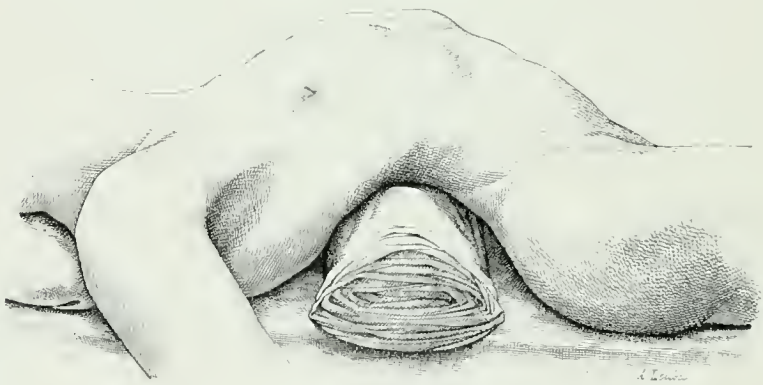

Fig. 309.—Position of the trunk in operations on the liver.

the course of the operation: the head is kept low, and ether is used as the anæsthetic; the dorsal position is employed, with a thick cushion placed transversely under the lower dorsal region, as shown in *Fig.* 309.

1. **Ways of Approach to the Liver.**—The most important point is to provide appropriate and adequate access; the chief difficulty often lies in obtaining satisfactory exposure of the hepatic lesion. Therefore the plan of **enlarging the primary wound** has only a very limited application, as it gives usually very imperfect access and allows only an incomplete examination owing to the tension of the surrounding muscles and aponeuroses.

The incision of choice is the **median supra-umbilical incision, combined if required with an extension either transversely or parallel to the right costal margin.** When sufficiently long, extending from the xiphisternum to the umbilicus, the median incision—if the edges of the

wound are well retracted—allows the left lobe and a large part of the anterior border and of the convex surface to be examined; through it the gall-bladder and bile-ducts are readily exposed. But the wounds of *the convex surface of the right lobe*, and those on either surface in the vicinity of *the posterior border*, are with difficulty reached by this route. A good deal of additional room is provided by dividing the rectus muscle transversely; it is better, however, to make the complementary incision parallel to the costal border; in this way a better exposure of the convex surface is obtained and downward displacement of the liver is easier (*Fig.* 310).

A vertical incision along the outer border of the rectus muscle extending from the costal margin to the level of the umbilicus may be used: if necessary further access may be provided by a transverse or oblique (*Fig.* 310) extension; if the costal arch is raised by the hands of an assistant, placed as shown in *Fig.* 311, much more room is given.

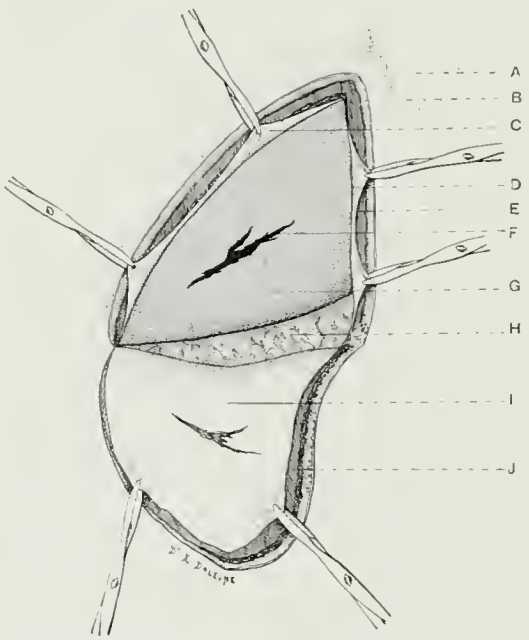

Fig. 310.—Way of approach to the liver: Vertical incision along the outer border of the rectus muscle; oblique incision along the costal border; flap turned down. (A) Xiphisternum. (B) Subcutaneous tissue. (CD) Parietal peritoneum. (E) Rectus muscle. (F) Wound of the convexity of the right lobe of the liver. (G) Liver. (H) Great omentum. (I) Flap turned down. (J) Muscular layer.

In some cases where the lesions are seated *very far back*, a long incision is made through the soft parts parallel to the costal margin:[1] then, by carrying the knife along the deep surface of the cartilage of the 10th rib, the diaphragmatic attachments are separated bit by bit, the pleural cul-de-sac with the overlying fatty tissue being pushed out of the way by a finger introduced through the opening: then the cartilages of the 8th, 9th, and

[1] This is the method recommended by Prof. Lannelongue for opening some perihepatic tuberculous abscesses (*Congrès de chir.*, 1888, p. 358). Canniot has shown that the inferior pleural cul-de-sac, after lying in relation to the peritoneum at the sides of the xiphoid appendix, reascends behind the 7th costal cartilage, crosses the 7th space, then passes obliquely downwards and backwards, crossing the 8th, 9th, and 10th costal cartilages: "the lower the rib in the series, the nearer does the pleura approach the bony portion." (*De la résection du bord inférieur du thorax, pour aborder la face convexe du foie.* Thèse de doct., 1891.)

Practically, owing to the preliminary displacement of the cul-de-sac, the junction of the ribs and cartilages may be taken as the external limit of the resection, and, if necessary, a segment of the 7th cartilage and even a portion of the 8th rib may be excised. It will, however, only be under exceptional circumstances that this method will be required.

10th ribs are divided at their costal and anterior extremities. By raising the cartilaginous flap and retracting the diaphragm upwards the distant parts of the convex surface will be exposed.

In *transpleural* and *transdiaphragmatic* wounds, the injured area has sometimes been reached by enlarging and following the *track* of the wounding instrument or projectile, resecting one or more ribs, and incising the diaphragm. (*See* THORACICO-ABDOMINAL WOUNDS.)

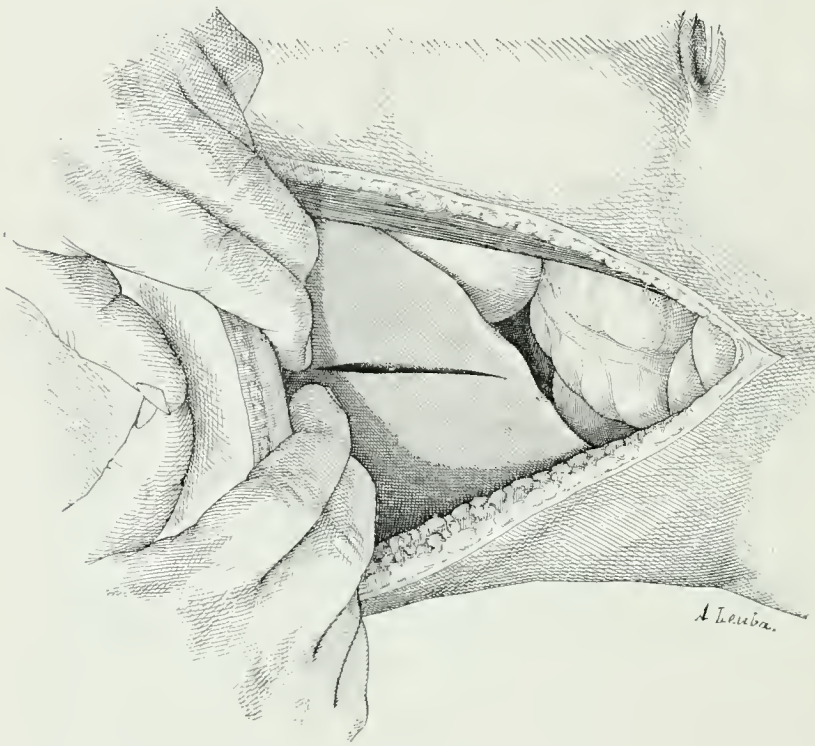

Fig. 311.—Laparotomy for a wound of the liver.
Incision along the outer border of the rectus muscle. The fingers of an assistant raising the costal border.

In a patient of Dalton's the wound of entry was situated in the 7th intercostal space: by resecting 4 inches of the 7th rib and incising the diaphragm over a length of 3 inches he succeeded in examining and suturing a wound of the liver.[1]

[1] In a case reported by Ch. Lenormand the patient had received an injury to the lower right part of the thorax from the explosion of a charge of gun-cotton. At that region there were three contused wounds, all penetrating to the pleura. The wounds were joined by a curved incision, and the necessary room was obtained by removing the fragments of the fractured cartilages and by resecting portions of the adjacent ribs with the gouge-forceps. Through the widely-opened pleura, a wound of the diaphragm about 5 inches long was then seen, and a laceration of the liver 2½ inches in length, which was bleeding profusely. The hepatic wound was closed by four sutures of thick silk introduced with a curved Reverdin needle, which entered the hepatic tissue at about two fingers' breadth from the wound, and emerged at a corresponding

At other times the *abdominal* and *transpleural* routes are combined. Such was the method adopted by M. Terrier in a very instructive case. The patient had been shot with a revolver in the 8th right intercostal space; the bullet track was enlarged and explored, and was found to pass between the 8th and 9th costal cartilages, through the diaphragm and into the abdominal cavity. Laparotomy was performed, and as soon as the peritoneum was opened, a quantity, estimated at about a glassful, of arterial blood escaped; it appeared to come quite definitely from the convex surface of the liver; the wound was enlarged downwards, and the omentum and intestine were found to be uninjured; it was then extended upwards, and the wound in the diaphragm and that in the liver, the latter situated very high up on the convex surface of the organ, could be felt with the finger. The thoracic and abdominal incisions were then joined by resecting two costal cartilages and dividing the soft thoracico-abdominal tissues between two clamps. *An assistant placing his hand in the abdomen was then able to push the liver downwards en masse*, so as to render accessible the wound on its convexity.

I have employed a similar method in the case of a young man of nineteen years who, fifteen hours before, had shot himself in the right base of the chest with a revolver. The wound of entry was situated over the 8th space in front. I enlarged the wound, excised two costal cartilages, and followed the bullet-track into the pleura, which contained a considerable quantity of blood: no definite opening was to be seen in the diaphragm. The abdomen was therefore opened by an incision at the outer border of the right rectus muscle: some red blood escaped, evidently coming from the convexity of the liver; *I divided what remained of the cartilaginous thoracic margin from below upwards*, then the diaphragm over a limited extent from before backwards; when the wound edges were widely retracted and the liver pushed downwards, the star-shaped and fissured hepatic wound, situated right at the back of the convex surface, came into view, and, facing it, the diaphragmatic perforation. The liver wound was closed by three sutures of heavy catgut, and the diaphragmatic perforation was also closed; a gauze mesh was placed in contact with the damaged area the end of the gauze being brought out at the upper angle of the abdominal wound, the rest of which was closed: the incision in the anterior part of the diaphragm and the divided costal cartilages were sutured. Drainage of the pleura. Recovery.[1]

2. **Hepatic Hæmostasis.**—Once the way is opened the first care of the operator is to wipe up the blood and search with eye and finger for the bleeding point. He may meet with any one of several conditions.

(*a*). **Wounds of the Anterior Border.**—These are the most easily

distance on the other side. The wound in the diaphragm was partly sutured with catgut, a gauze mesh being left in contact with the liver and another in the pleural cavity, the external ends being brought out through the parietal wound, which was left partly open. The patient recovered. (GERARD MARCHAND. *Soc. de chir.*, 10 déc., 1900, p. 1141.)

[1] *Soc. de chir.*, 29 juillet, 1903.

found. The border of the liver is involved to a variable depth in the form of a *gaping shallow wound* or *a fissure*, or sometimes of an *almost complete rupture*.[1] Under such circumstances the liver must be sutured by one or other of the following methods :—

(i). If the wound is not very deep, limited to the anterior border, or at any rate not extending beyond the comparatively thin tongue-like anterior portion of the organ, it will be closed by several **interrupted sutures passing through the whole thickness of the liver tissue from one surface to the other.** *Fig.* 312 shows one of the sutures completed and a second in process of execution.

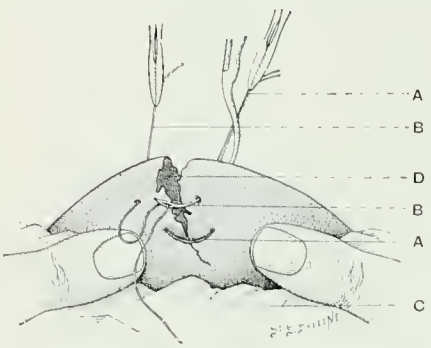

Fig. 312.—Wound and suture of the anterior border of the liver. (AA) First suture, tied. (BB) Passing the second suture in two stages. (C) Protecting compress. (D) Wound of the liver.

The anterior border of the liver is raised and held between the fingers of an assistant in the manner represented in the same figure, and the wound is well exposed. No attempt should be made to pass the sutures through both edges of the wound with a single movement of the needle, because, owing to the thickness and friability of the tissues, tearing is almost sure to result. Each suture must be passed *in two steps* with a large curved needle : the needle, introduced first from below upwards, at a distance of $\frac{3}{4}$ inch at least from the wound, draws the thread through from the upper to the lower surface ; then, being introduced again on the opposite side of the wound, this time from above downwards, it is brought through the other edge in the contrary direction : the two ends are then tightened *gently and steadily*, and knotted. The first suture will naturally be placed at the deepest part of the wound and the others at regular intervals from behind forwards.

(ii). If the solution of continuity extends very far, passing deeply into the thickness of the lobe, this method of union becomes impracticable, and **it is necessary to suture the upper and lower surfaces separately**—in the manner which we shall immediately describe—except in the anterior thinner part of the organ, where the perforating sutures will be employed as before.[2]

[1] As in the case of a patient of Krönlein, who had been a fortnight previously trampled upon by a bull. On opening the abdomen a large quantity of black bile escaped, and a gaping antero-posterior fissure was found on the upper surface of the liver to the right of the falciform ligament : the fissure extended downwards and backwards, and left intact only the posterior border at the level of the coronary ligament. *The entire organ was thus practically divided into two portions.* The margins of the wound were brought together by three silk sutures, two on the upper surface, one on the lower. The gall-bladder was uninjured. It is worthy of note that, notwithstanding the dimensions of the fissure, there had been comparatively little bleeding, but a very considerable effusion of bile (about two quarts had previously been evacuated by puncture).

[2] In those cases where profuse hæmorrhage from the enormous wounds threatens immediate death, Socin's plan of producing *temporary hæmostasis by compressing the liver widely between the hands* must not be forgotten. (*Soc. de chir.*, 8 fév., 1899.) Or, following the recommenda-

(*b*). **Wounds of the Convex Surface.**—These wounds naturally vary very much in shape, direction, length, and degree of gaping; their most important characteristic is that from their situation they are difficult of access. It is therefore almost always necessary **to displace the liver downwards and to incline the upper surface forwards** in order to expose it as completely as possible.

The best method of attaining this object is for an assistant to introduce two or three fingers (*Fig.* 313) or even the whole hand deeply between the diaphragm and the liver, and to press the latter downwards and forwards. Thus placed, the fingers of the assistant are kept in position during the whole time necessary for suturing the wound, and are of very great assistance.

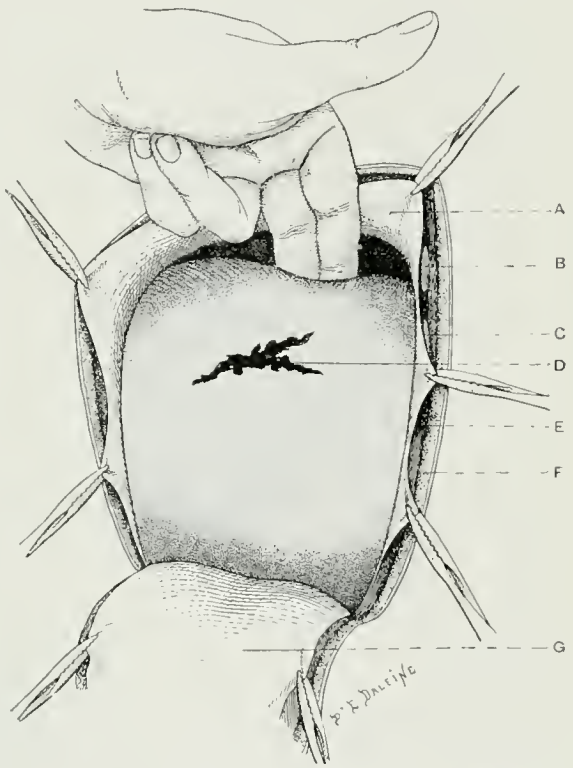

Fig. 313.—Displacement downwards and rotation forwards of the liver. (A) Parietal peritoneum, secured with forceps. (BC) Divided costal cartilages. (D) Wound on the convexity of the liver close to the posterior border. (E) Rectus muscle. (F) Subcutaneous tissue. (G) Flap turned down.

We have already, when speaking of wounds of the anterior border, recommended suture as the best means of obtaining hæmostasis; it is equally applicable to all forms of wounds and ruptures. The thermo-cautery, at a dull red heat, is a very uncertain and therefore dangerous agent; gauze packing, properly done, constitutes a last resort in cases where the seat of the injury or the friability of the liver tissue renders suture impossible.

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tion of M. L. Macaggi, compression of the hepatic pedicle (the right free margin of the gastro-hepatic omentum) may first be tried: if, notwithstanding proper compression, hæmorrhage still persists, there will be reason for thinking its source is from some other organ than the liver; if the bleeding becomes much more abundant, then the compression should be immediately discontinued and a search directed to the area drained by the tributaries of the portal vein": if, after suture of the hepatic wound, bleeding recurs as soon as compression of the pedicle is suspended, it will indicate that there is another wound of the liver undetected. ("Sulla emostasi provisoria del Fegato." *Liguria medica*, 1908, ii., 12.)

In order to suture the liver it is necessary, as we have already said, to use a large curved needle and *thick thread*, silk or catgut. The important point in a liver suture is to take **a wide and deep grasp of the tissues** on either side of the wound, the thread entering and emerging at a distance of an inch from the margins, and passing deeply enough in the hepatic tissue to lie below the bottom angle of the wound, so that it may bring the two opposed surfaces together in their entire depth (*Fig.* 314).

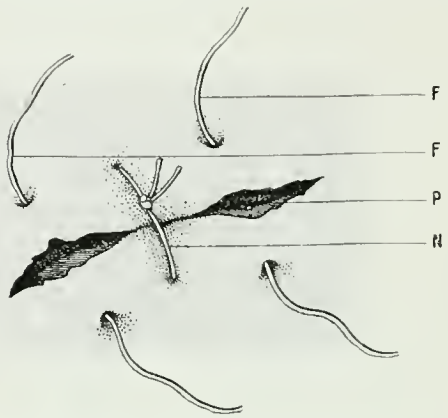

Fig. 314.—Suture of the liver. (FF) The two lateral sutures passed deeply into the hepatic tissue. (P) Wound of the liver. (N) The middle suture, tied first.

If the sutures are not passed deeply enough, a blind space will be left at the bottom of the wound in which blood will accumulate, displacing the surrounding tissues, and possibly even causing the cortical suture to give way. With the liver, as with the kidney, if the needle is too timidly used, picking up only narrow bands of tissue on either side, satisfactory results will not be obtained; the threads will cut out as soon as any traction is applied, the fissures so produced will bleed, and, in the end, the operator will be compelled to introduce the sutures widely and deeply and under less favourable conditions than at first.

It is generally a good practice when dealing with a longitudinal wound to **begin by placing a median suture** (*Fig.* 314), which becomes in a way the keystone of the arch of union, and to complete the junction by one or more secondary sutures on either side.

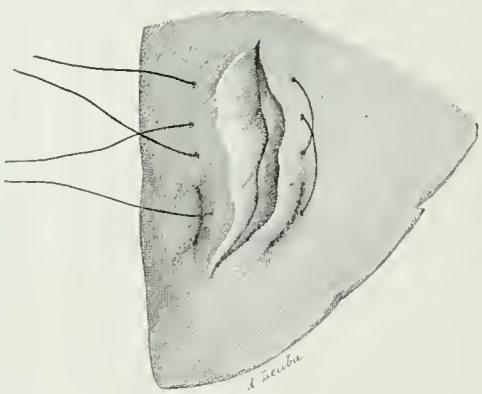

Fig. 315.—Suture of a wound of the liver by transverse overlapping loops.

If the wound is *very long and gaping*, it is best to introduce all the sutures first and then to begin to tie them at the extremities of the wound, working towards the centre; at the ends the tension is less; the two edges are thus brought together gradually, and there is less danger of tearing when the time comes for tying the central threads.

The *tightening of the sutures* requires a good deal of care: a surgeon's knot is made and *moderate traction is exercised slowly, gently, and without jerking, on the two ends until the two surfaces of the wound are in close and uniform contact without undue pressure*; the knot will then be completed, and if catgut is being used it will be well to make a third turn in the knot for security.

The liver tissue will not bear constriction in the same degree as an aponeurosis or the skin; if the two opposed surfaces are pressed together they will be crushed and torn, and caused to bleed; hæmostasis requires nothing more than uniform contact between the two opposed surfaces, and, indeed, the friability of the liver tissue allows nothing else.[1]

Transverse loop sutures may also be employed in the manner shown in *Fig.* 315, by means of which broad surfaces can be held in contact. The more elaborate method of Canac-Marquis consists of two series of loops formed with a single thread (*Figs.* 316 and 317). It has been used successfully by its inventor in treating a wound 3 inches long and about 2 inches in depth on the convex surface of the liver.[2]

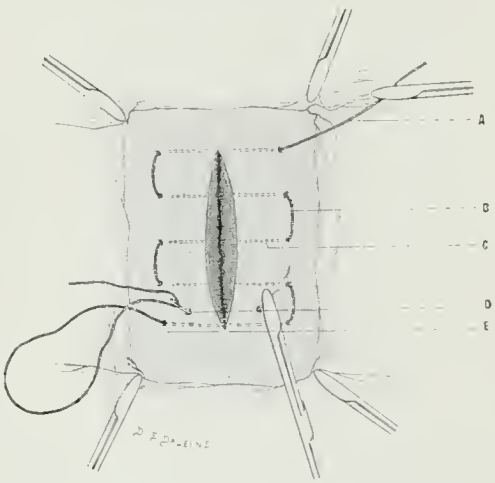

Fig. 316.—Suture of a long wound of the liver (Canac-Marquis.) The thread has described the first series of transverse loops and is beginning the second. (A) Initial extremity. (B) Superficial middle portion of a loop. (C) The deep part, intra-hepatic. (D) Needle passing under the two lips at a finger's breadth from the wound, and introducing the first of the second series of loops. (E) End of the first series of loops.

Of course, if perfectly satisfactory union has not been obtained, and some oozing still persists, supplementary gauze packing will be employed.

(*c*). **Wounds of the Inferior Surface and Posterior Border.**—The presence of the great vessels in the hilum renders these injuries peculiarly serious and sometimes irremediable; indeed, wounds of the portal vein or its large branches as a general rule allow no time for any intervention, and even if operation is possible the results are exceedingly doubtful; to leave a clamp on a wounded portal vein is simply to defer the fatal issue. In such a condition venous suture is the sole available resource.

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[1] In addition to the deep sutures some superficial ones have occasionally been employed with the object of obtaining perfect adjustment of the margins; no reliance can ever be placed on these capsular sutures, and they are usually unnecessary when the deep sutures have been properly placed.

[2] F. P. Canac-Marquis, of St. Paul, Minnesota. "Un procédé de suture des plaies du foie." *Presse méd.*, 11 juillet, 1900, p. 13.

Lesions of the inferior surfaces of the two lateral or the median lobes require first of all to be sufficiently exposed, and to render them accessible it is necessary to employ a different scheme from that which we have already described: **raise the anterior border and rotate the organ as much as possible from below upwards and from before backwards around a transverse axis, and push it up en masse into the hollow of the diaphragm,** while at the same time displacing the omentum, duodenum, stomach, and colon downwards as far as possible under a compress. By means of this manœuvre, if properly performed, it is possible to see and to suture fissures of the posterior border. The following case of Schlatter's may be taken as an example.

It was a rupture by contusion resulting from the passage of the wheel of a vehicle over the injured man, who was in a state of extreme anæmia. The abdomen was first opened in the middle line, from the xiphisternum to the umbilicus. A large quantity of dark blood immediately escaped, but a hand introduced into the abdomen to explore the liver failed to find any laceration of the anterior portion of the organ; the extravasated blood interfered seriously with the examination, and before going further it was necessary to evacuate it by means of the hands and swabs; there were quite four pints of blood diffused throughout the abdominal cavity. The stomach and colon were then pushed downwards under a warm sterile compress, and it became possible to inspect the liver. No trace of injury was discovered on the upper surface or on the anterior part of the lower surface; the question was then raised as to the rupture being in the spleen or one of the kidneys, and those organs were examined, with negative results. However, the blood still continued to flow from the depths of the cavity.

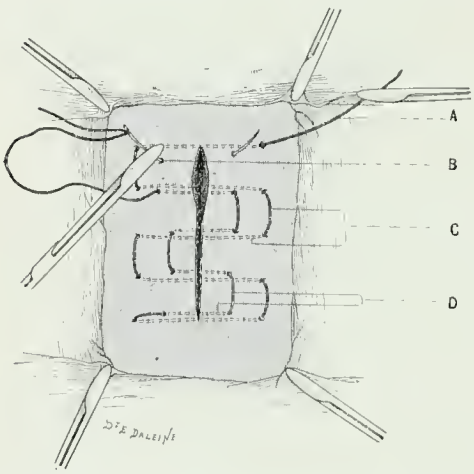

Fig. 317.—Suture of a long wound of the liver (Canac-Marquis). Both series of loops are completed. (A) Initial extremity. (B) Needle completing the last loop: the two ends will be tied together, and the suture will then be finished. (C) Long loops, first series. (D) Short loops, second series.

After having repeatedly palpated both surfaces of the liver, the fingers at last detected *a large fissure with everted margins situated behind Spiegel's lobe*, extending upwards and backwards. By pushing the anterior part of the organ strongly upwards against the right costal arch, and with persistent sponging, it was possible to see the anterior end of the fissure. A piece of hepatic tissue had even been completely torn away and remained adherent to the capsule of the right kidney.

Suture of such a wound was manifestly impossible through the median

laparotomy incision. The opening was therefore enlarged by an oblique cut from the middle line along the costal margin out to the nipple line. In this manner, and *by pushing the liver up into the hollow of the diaphragm and depressing the intestines under the hand of an assistant*, fairly good access was obtained to the wounded area, making it possible to close the wound by five sutures of thick catgut. None of the sutures cut out, and the bleeding was apparently arrested—at least, gauze swabs passed down to the seat of injury showed only a little blood.

In our opinion any persistent oozing of blood ought to be mistrusted, and it appears to us that under such circumstances the abdomen ought not to be completely closed, and that the bleeding focus ought to be packed.

Gauze packing is the sole available resource in cases where the rupture cannot be found, or, if found, cannot be sutured, and when blood is seen to well up from the depths.[1]

Every effort must nevertheless be devoted, with the aid of careful sponging, to determine the exact position of the bleeding spot, and instead of simply placing isolated strips of gauze in contact with it, it will be well to make a proper plug after the Mickulicz method, carrying the apex of the enveloping sheet of gauze on the finger tip or with long forceps right to the bottom of the focus (see *Fig.* 11).

(*d*). **Bullet Wounds.**—These possess certain peculiarities with which it is advisable to be acquainted.

First of all, they are often complicated by **radiating fissures**, situated on one or other surface of the organ and penetrating to various depths. These fissures often cause more bleeding than the perforation itself, and must be sutured in the manner described above.

When one bullet-hole has been found, a search must always be made for *a second*, because it may well be that the liver has been traversed from side to side by the projectile, and if the abdomen is closed after the bleeding from a wound of entry on the convexity has been arrested, hæmorrhage may still continue from a wound of exit on the concave surface. A careful examination of both surfaces is therefore essential.

There still remains the question of the projectile itself and **its extraction.**

Here, as when dealing with the brain or the lung, primary extraction is only to be undertaken when the bullet presents itself readily in a quite superficial situation, where it can be easily seized and removed. If not seriously pressed by hæmorrhage one may gently explore the track with

[1] Thus Hartmann packed a laceration situated on the under surface of the liver to the right of the gall-bladder, and succeeded in stopping the bleeding. Some statistics collected by Tricomi dealing with forty-nine cases of hepatic wounds give the following results: twenty-six wounds treated by suture, eight deaths; twenty-one treated by gauze packing, four deaths; two treated by the thermo-cautery, two recoveries (*Il Policlinico*, Nos. 18 and 20, 1899). This collection of cases demonstrates once more the great practical advantage of immediate intervention in injuries of the liver; from the figures alone, however, it is impossible to estimate the true comparative value of the different methods of hæmostasis; the thermo-cautery, and even gauze packing, are too favourably represented.

a probe or a sterilized elastic sound, and if nothing is detected the liver may be palpated between the two hands. Even when the ball is detected, if it lies at any depth, no attempt at extraction is advisable.

The object of the operation is **to check the hæmorrhage, not to extract the bullet**, and the best plan will be simply to close the wound of entry, which is often narrow, by some deeply-placed sutures in the manner already described, and if there is a wound of exit to treat it in the same way.

If access to the wound is difficult, if its edges are bruised and friable, it will be well to limit oneself to packing the track with a strip of aseptic gauze introduced as far as possible.

Wounds and Ruptures of the Biliary Passages.

These injuries co-exist fairly often with lesions of the hepatic parenchyma, and when laparotomy has been performed for the latter a very considerable quantity of bile may be found in the abdomen, mixed with blood; as a general rule the abdomen should never be closed under these conditions until a careful examination of the under surface and hilum of the liver has been made.

We have already mentioned that **injuries of the biliary passages alone have very seldom given cause for immediate operation.**[1] MM. Terrier and Auvray quote only the two cases of Kehr and Dalton, in both of which rapid recovery ensued.

In the first case the injury was caused by a revolver bullet: Kehr found a wound at the fundus of the gall-bladder and closed it with a double row of sutures; Dalton's patient had received a stab with a knife, and the intestine protruded through the wound: near the fundus of the gall-bladder there was a wound about $\frac{3}{4}$ inch in diameter; it was sutured, and the gall-bladder was surrounded by a strip of iodoform gauze, the end of which was brought out at the upper end of the abdominal incision. The gauze was removed on the second day and the wound healed without any discharge of bile.

[1] This rarity is due to the fact that the remission of the initial symptoms renders the diagnosis very uncertain. The slight peritoneal reaction is to be explained by the asepticity (relative at least) of the normal bile. After the primary shock has passed off, nothing is to be detected beyond a certain amount of pain, more or less acute, in the subhepatic region, often radiating to the right shoulder, moderate diffuse tenderness of the abdomen, and some vomiting, but no signs of grave infection; soon a fluctuating swelling of variable size, but situated chiefly in the right half of the abdomen, shows itself, and during the second week jaundice usually appears, accompanied (if there is a complete rupture of the common duct) with decoloration of the fæces. The extravasated bile produces only moderate irritation of the peritoneum and becomes encysted, and some patients have recovered spontaneously, or after one or more aspirations. But it is impossible to depend on such a benign course of events. If the biliary passages are diseased, if the bile is septic, diffuse peritonitis bursts forth with its usual gravity: furthermore, even in the mild cases, complications may suddenly develop at a late period, and, owing to the discharge of all the bile into the abdomen, the patients pass rapidly into a very grave state of malnutrition. These points all form reasons for early intervention. Of course the problem presents itself in quite a different fashion in cases of wounds caused by sharp instruments or firearms: then the single fact of a penetrating wound constitutes a definite and sufficient indication for operation. (See Wounds of the Abdomen).

These are encouraging cases, and of such a character as to indicate early laparotomy as the proper procedure when the pain, the signs of peritoneal reaction, and the dullness, furnish sufficient presumptions of a rupture of the biliary passages.

In such conditions Kehr's bayonet-shaped incision is particularly useful for the purpose of freely exposing the subhepatic region and the pedicle of the liver: it commences at the xiphisternum, descends first vertically and in the median line to a point midway between the xiphisternum and the umbilicus, then turns obliquely outwards to the right, parallel to the costal margin, until it reaches the mid-breadth of the rectus muscle, where it again becomes vertical, to end at the level of the umbilicus (*Fig.* 318).

Fig. 318.—Kehr's bayonet incision

Once the extravasated bile has been evacuated and the subhepatic region carefully cleansed, the gall-bladder will be examined by raising the anterior border of the liver, and then attention will be directed to the ducts.

1. **Wounds and Ruptures of the Gall-Bladder.**—When the gall-bladder is wounded the treatment will vary according to the nature and extent of the lesions; a circular perforation, a short fissure in the neighbourhood of the fundus, even a longitudinal wound occupying a considerable length of the under surface, but with clean-cut and healthy borders, may be **closed by suture at once.**

The solution of continuity must be quite recent if this method is to be followed without danger. The margins of the wound must be carefully freshened, any contused or lacerated patches excised (particularly after bullet wounds) and the suturing properly done. The best plan is to introduce **two layers of sutures** as for the intestine: a deep continuous suture of catgut and a superficial one of silk: the former must include the *whole thickness of the walls* on either side of the wound, thus producing complete mechanical closure; the latter covering and burying the first. The second continuous suture is in fact a Lembert suture: it includes the serous and muscular coats only, and brings the serous surfaces on either side of the line of union into contact (*Fig.* 319).

After completely closing the gall-bladder in this manner, even though

the conditions are such as to cause little doubt, it will be advisable and safer to place a drain in contact with the suture line and to leave the parietal wound partly open; if all goes well the drain may be removed on the second day, and will not have delayed healing.

When the wound in the gall-bladder is lacerated and irregular, if speed is of importance, the margins may simply be stitched to the external wound as in performing ordinary cholecystotomy, and later, if the ducts are uninjured, the fistula will usually close spontaneously or with the aid of a very simple secondary operation.

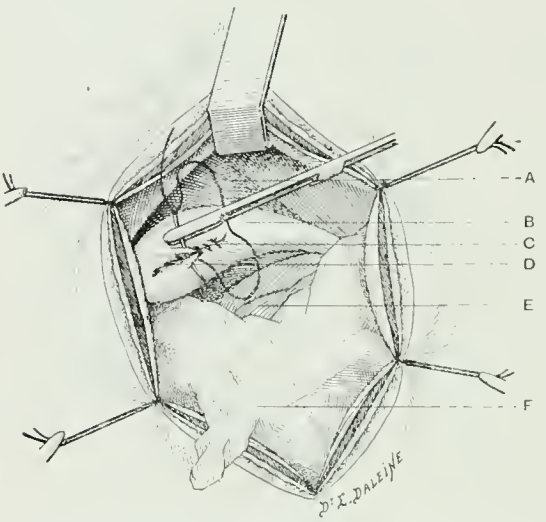

Fig. 319.—Suture of the gall-bladder. (A) Under surface of liver, raised by retractor. (B) Gall-bladder. (C) Introducing the outer sero-serous continuous suture. (D) Inner continuous suture, including all coats. (E) Duodenum. (F) Protecting compress.

Lastly, if the lesions are very extensive, the gall-bladder being badly torn discoloured, and perhaps soiled, the best plan is to remove it at once, that is, to perform **cholecystectomy**, which really is not a very difficult operation. The most troublesome step in complete removal of the gall-bladder *is the freeing of its upper surface*, and separating it from the hepatic tissue in which it is partly embedded; the difficulty, moreover, varies very much in different cases. Some gall-bladders are attached to the liver only by a narrow surface, and then the separation presents not the slightest difficulty; when, however, the area of adhesion is broad, considerable caution and care are necessary to avoid tearing the liver tissue and causing troublesome bleeding. The opening in the gall-bladder is closed by the application of forceps, which serves to prevent leakage, and at the same time as a means of applying traction to the organ; the separation is begun at the fundus or at one of the lateral borders, and is gently pursued with the finger or a director; there is a plane of cleavage between the liver and gall-bladder which greatly facilitates the separation when the operator knows where to find it and how to keep to it (*Fig.* 320). This plan is much superior to that of dissecting the gall-bladder from the liver with the thermo-cautery, which is besides never completely hæmostatic; after the enucleation is completed, however, the cautery at a very dull red heat may serve to check any oozing. As soon as the gall-bladder is free and turned down, the further steps of the operation become comparatively simple; a good ligature—it is well to make it double—on the pedicle, or better, two separate ligatures, one on the cystic duct, the other on the cystic artery

(*Fig.* 321), section of the pedicle, and cauterization of the stump complete the undertaking.

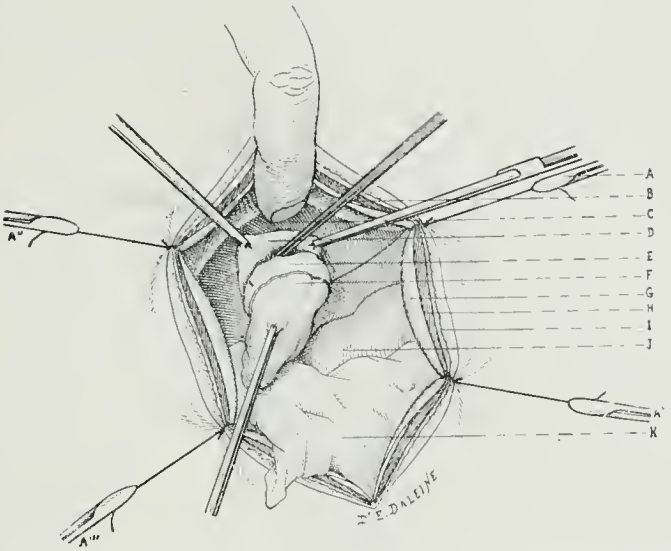

Fig. 320.—Cholecystectomy: Separating the gall-bladder from the under surface of the liver. (AA') Sutures securing peritoneal edges, and used as retractors. (B) Director separating the gall-bladder. (C) Finger raising the anterior border of the liver. (D) Serous covering of the gall-bladder, divided and raised. (E) Upper surface of the gall-bladder.—(F) The empty gall-bladder, held and depressed by a forceps. (G) Peritoneum. (H) Rectus muscle. (I) Aponeurosis. (J) First part of the duodenum. (K) Protecting compress.

2. **Wounds and Ruptures of the Bile Ducts.**—Isolated lesions of the bile-ducts are very uncommon: further, they express themselves by no immediate serious symptoms, and consequently remain for a longer or shorter time unrecognized. However, the possibility must be kept in mind after injuries affecting the epigastrium or right hypochondrium: the detection of increasing iliac dullness which indicates continued intra-peritoneal effusion; the presence of bile pigments in the urine; the decoloration, complete or partial, of the fæces; the appearance of jaundice (which occurs however

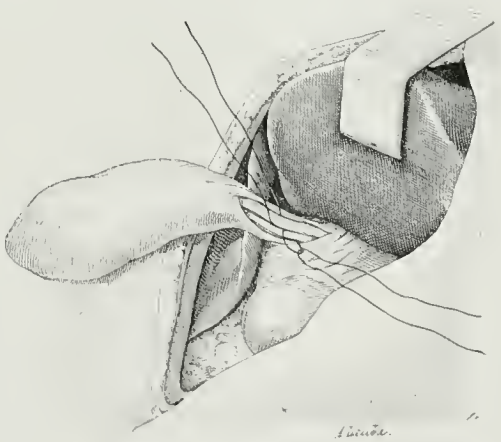

Fig. 321.—Cholecystectomy: Independent ligatures of the cystic duct and cystic artery.

only in a moiety of the cases) form quite sufficient indications for operation.

It must not be forgotten that though ruptures of the subhepatic ducts and the consequent diffusion of bile do not as a rule produce peritonitis, their prognosis is still bad, and that they cause death after a longer or shorter interval; early operation gives the best chances of discovering the rupture and of being able to treat it adequately.

However, so far as can be gathered from cases actually recorded, surgical action has been confined in most instances to the provision of drainage—either of the subhepatic region, or direct drainage of the hepatic or common ducts. Experience shows that this suffices for recovery.

Usually the subhepatic focus has been opened and emptied, the pedicle is examined, and no rupture is found, or at the most its position is only suspected under the infiltrated tissues; any minute and prolonged search is contraindicated; a drainage tube surrounded with strips of gauze is introduced, and the parietal wound is partly closed.

In Tuffier's case[1] operation was performed on the fifth day. Through an iliac incision several pints of bile were evacuated; through an epigastric incision a diffuse subhepatic biliary infiltration was discovered; the abdomen was drained by both incisions. The patient was cured in forty-five days. Rothfuchs on the eighteenth day, Garré on the twentieth day, performed similar operations and obtained similar results. Hahn operated six weeks after the accident. He opened two cavities containing bile and surrounded by false membrane, but failed to find the rupture, and packed the cavities with gauze; ten days later he operated again, and succeeded in finding a laceration of the common duct, behind the first part of the duodenum. Suture was impracticable; he therefore packed afresh, and the patient recovered.[2]

If during the examination of the bile-ducts the rupture can be definitely seen, the best plan is not to try to suture it, but to introduce a non-perforated rubber tube into the wounded duct, to arrange some layers of gauze around it, and so to drain the hepatic duct in the manner commonly employed after choledochotomy. In a child of 5 years, Hildebrandt,[3] operating on the twenty-thrid day, discovered a longitudinal tear, about a third of an inch in length, of the hepatic duct; he tried to suture it, but the threads cut out, and he was obliged to content himself with direct drainage of the duct. The child had recovered at the end of a month. In a somewhat similar case, Bessel-Hagen[4] on the second day found a laceration of the hepatic duct, but the surrounding diffuse infiltration prevented the intro-

[1] Tuffier, "Rupture traumatique du canal cholédoque." Guérison. *Bull. et Mém. de la Soc. de chir. de Paris*, 2 mai, 1906, p. 463.

[2] Meissner ("Die Zerreissungen der Gallenausführungsgänge durch stumpfe Gewalt." *Beiträge f. klin. Chirurgie*, 1907, liv., 1, p. 204) has collected twelve cases of traumatic rupture of the common bile-duct with eight deaths, seven cases of rupture of the hepatic duct with five deaths.

[3] Hildebrandt, "Ueber die traumatische Ruptur des Ductus Hepaticus." *Archiv f. klin. Chir.*, 1906, lxxxi., 1, p. 647.

[4] Bessel-Hagen, *Medicinische Klinik*, 1906, No. 52.

duction of a tube; he contented himself with packing the area, and recovery ensued.[1]

In cases of complete rupture of the hepatic or common duct, an attempt should always be made to bring the two ends together, at least by their posterior borders: or again, the upper end may be implanted into the intestine. If it is the common duct which is completely divided, cholecystenterostomy is available; Lewerenz has employed this plan with success.[2]

Finally, a complete tear of the cystic duct will necessitate ligature of the duct and cholecystectomy; Lessing[3] has published a case of this kind which also terminated in recovery.

INJURIES OF THE LEFT HYPOCHONDRIUM. URGENT SURGERY OF THE SPLEEN. WOUNDS AND RUPTURES OF THE PANCREAS.

The injuries of the left hypochondrium may be of very varied character, and, according to the direction of the wounding instrument, the base of the lung, the diaphragm, the spleen, the fundus of the stomach, the left lobe of the liver, the intestine, or the pancreas may be involved. Indications are regulated by the same principles as in the case of the analogous injuries of the right hypochondrium.

Here we shall confine ourselves to a discussion of the urgent surgery of the spleen and some details regarding wounds and ruptures of the pancreas.

The Urgent Surgery of the Spleen.

This finds its application in three conditions: (1) *In ruptures*; (2) *In wounds caused by sharp instruments or firearms*; and (3) *In traumatic hernia of the spleen.*

1. **Ruptures of the Spleen.**—The symptomatology is very indefinite and of very little localizing value. For the diagnosis of a rupture of the spleen there are only two factors: the signs of *serious internal hæmorrhage*, with the associated peritoneal reaction; and the history of

[1] Of course subsequent cicatricial stenosis or obliteration of the canal is always to be feared after extensive and irregular tears. In a case of rupture of the hepatic duct, situated very high up, and operated on at the end of five weeks, M. Garré was compelled to confine himself to packing and drainage: the patient returned to the hospital a year and a half later in a grave condition of jaundice. Owing to the impossibility of dealing directly with the cicatrix in the canal, M. Garré incised Glisson's capsule at a part of the left lobe of the liver where the superficial bile-ducts appeared greatly dilated, and anastomosed the incision to an opening in the duodenum; the jaundice disappeared, and permanent recovery followed this hepato-cholangio-enterostomy. (*Congrès français de chirurgie*, 1908.)

[2] Lewerenz. "Ueber die subcutanen Rupturen der Gallenwege traumatischen Ursprungs." *Archiv f. klin. Chir.*, 1905, lxxi., 1, p. 111.

[3] Lessing, *Deutsche med. Woch.*, 1907, No. 1.

a violent contusion acting on the *base of the thorax, the left hypochondrium*, or *the left flank*. These points are often, however, quite sufficient to indicate the urgent need for immediate operation.

In passing, we need only refer to the ruptures of malarial spleens to which attention has been drawn by Vincent,[1] and which may result from a comparatively trivial injury or may even occur spontaneously. The knowledge of a pre-existing pathological state of the spleen is always important, and may furnish strong presumptive indications of the localization of a traumatic lesion.

In the presence of signs of serious intra-abdominal hæmorrhage it is always wise to operate and to place no reliance on any indirect measures,

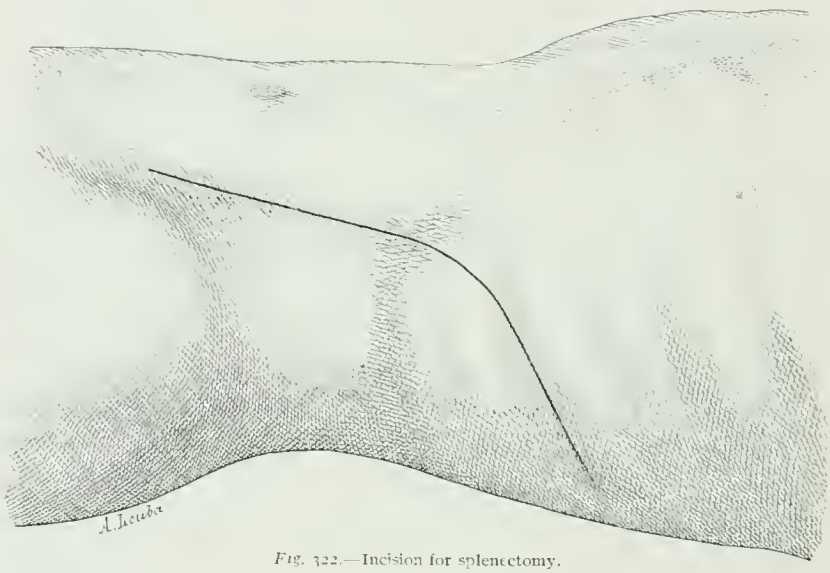

Fig. 322.—Incision for splenectomy.

such as compression, or iced applications, which in the case of rupture of so vascular an organ are quite useless.

If in doubt as to the seat of the bleeding, the abdomen ought to be opened in the middle line above the umbilicus, and through this exploratory incision a search be made for the lesion by sight and touch, endeavouring to follow the track of the blood and clots. If the spleen is found to be injured, it is impossible to carry out satisfactorily the necessary further steps by way of the median incision, or at least it will be necessary to provide freer access by carrying a long oblique incision from the upper extremity of the primary one downwards and to the left, parallel to the costal border.

When the flap thus cut is turned down, a fair amount of room is

[1] Vincent, "Sur le pronostic et le traitement des ruptures de la rate." *Revue de chirurgie*, juin, 1893, p. 449.

provided, but very often access is still too limited, and permits neither a complete view of the area nor the liberation and easy extraction of the upper pole of the damaged organ.

M. Auvray has proposed—and performed successfully in one case[1]—the resection of the cartilaginous margin of the thorax, and certainly the method remarkably facilitates splenectomy, particularly in the case of those ruptured, crushed, friable spleens which tear and come to pieces under the hand, a state of affairs which is naturally associated with a great increase in the bleeding. Therefore, when it is practically certain that the symptoms are due to a splenic lesion, it will be a good plan to make the primary incision, not in the middle line, but along the outer border

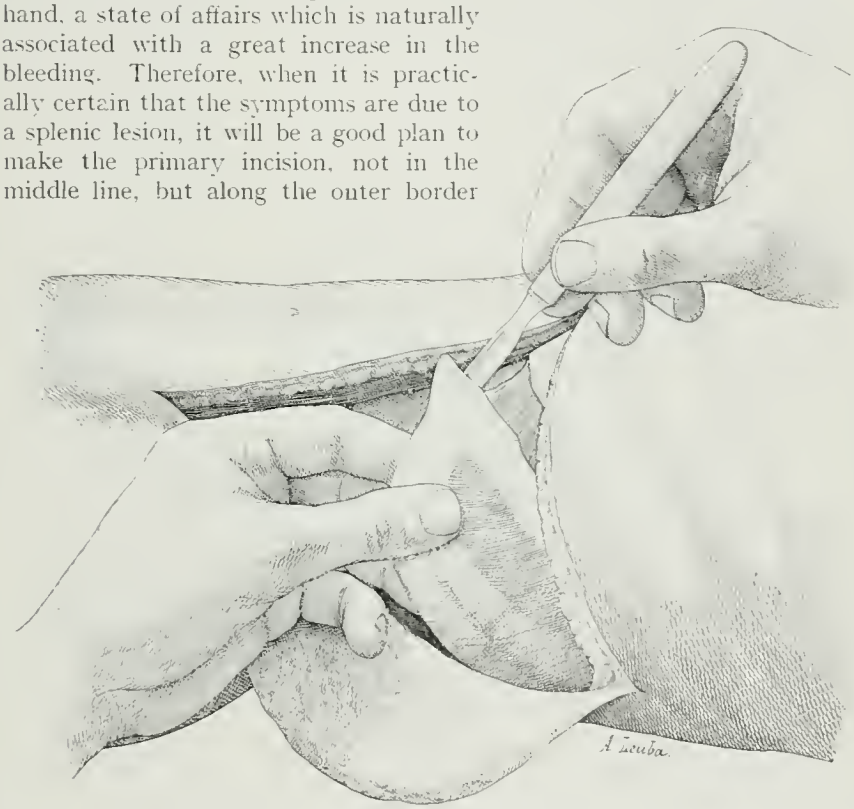

Fig. 323.—Splenectomy. Excising the cartilaginous margin of the thorax.

of the left rectus muscle, and once the diagnosis is confirmed, to prolong it outwards and backwards over the lower part of the thorax at the level of the 8th space, as shown in *Fig.* 322. In this way a flap of the soft tissues is cut which, when dissected up and turned downwards, freely exposes the cartilaginous thoracic border, in other words, the 10th, 9th, and 8th cartilages. These cartilages are then divided, with the knife or scissors, close to their anterior extremities, and freed, from before backwards and from below upwards, the knife being kept very close to the deep surface during

[1] Auvray, "Rupture traumatique de la rate et résection du rebord cartilagineux du thorax," *Presse médicale*, 4 jan., 1905, No. 17.

the separation of the underlying soft tissues (*Fig.* 323). Finally, the thoracic segment is excised by cutting the cartilages a little in front of the costo-chondral junction. Then, by gently retracting the soft tissues with the fingers, and raising the remains of the thoracic border with a broad retractor, the whole spleen will be exposed, and it will be possible to examine its anterior border, the external surface, and the two portions, separated by the attachment of the gastro-splenic omentum, of the internal surface,[1] and it will be easily possible to draw down the upper pole (*Fig.* 324).

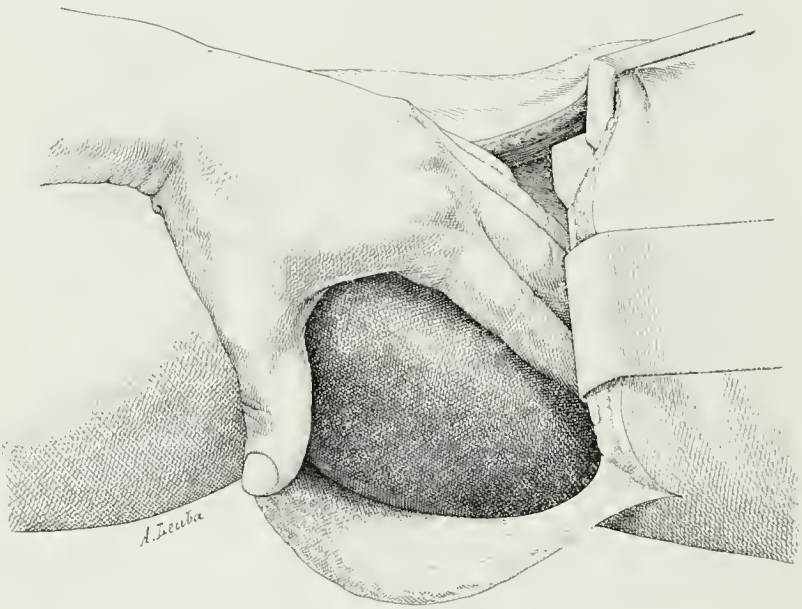

Fig. 324.—Splenectomy. Extraction of the spleen, bringing down the upper pole.

When the spleen is found to be ruptured the safest procedure is to remove it. Often, indeed, the condition of the organ—pulpified, deeply fissured, or divided into multiple segments—and the violence of the hæmorrhage, allow no other choice.

With adequate access and an organ but little hypertrophied and not adherent, splenectomy is not a very difficult operation, and there have been many successful cases.[2]

[1] We shall presently have occasion to mention an instance of rupture of the posterior portion of the inner surface which, being hidden by the gastro-splenic omentum, was overlooked and caused the patient's death.

[2] A case treated by Paul Delbet may serve as an example.[3] Violent contusion of the left hypochondrium by the shaft of a carriage; signs of internal hæmorrhage. Laparotomy was performed and the abdomen found full of blood, which came from a rupture of the spleen. The pedicle was clamped, the organ excised, a ligature applied, the abdomen cleared of blood and clot, and the parietal wound completely closed. Recovery. There was a transverse fissure in

After the abdomen is opened, and the blood and clots rapidly wiped away, as soon as a rupture of the spleen[1] is discovered, go straight to the pedicle and seize it between the fingers: once the bleeding has been checked in this way, two clamps will be substituted for the fingers (*Fig.* 325). The spleen or its fragments are then drawn outside the abdomen, and the pedicle divided close to the hilum beyond the clamps; each of the two segments of the stump is secured by a locking ligature—Lawson Tait's knot, for instance—and the ends of the two ligatures are tied together; in addition to these mass ligatures, it will be advisable to secure the larger vessels in the face of the stump with separate security ligatures.

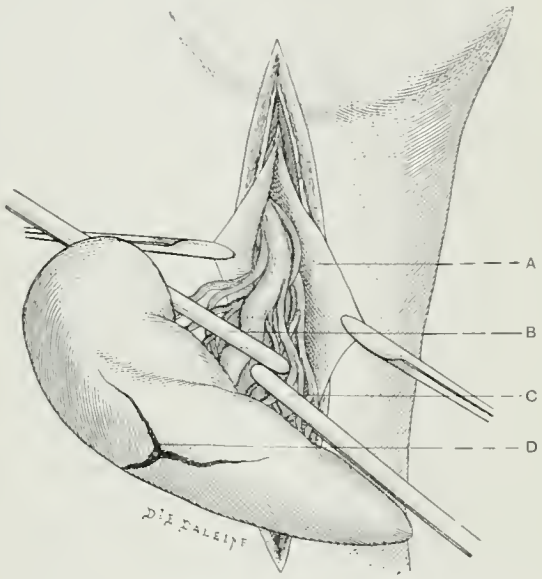

Fig. 325.—The splenic pedicle clamped. (A) Parietal peritoneum secured with forceps. (B, C) The two clamps applied with the tips overlapping to the two portions, upper and lower, of the pedicle. (D) Lacerated wound.

When dealing with a large adherent spleen which tears and bleeds badly on the slightest attempt at separation, the operation becomes a very different and difficult matter: it is necessary to go at once to the pedicle, try to expose it and to compress it between the fingers, then to clamp it and divide it bit by bit, before proceeding with the liberation and extraction of the organ.

I may add that in these hypertrophic conditions splenectomy is in itself a very serious operation.

When removal is impossible, leaving a clamp on the pedicle or tight

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the spleen about 2 in. long and ½ in. deep. (Reported by M. Le Dentu, *Acad. de méd.*, 27 déc., 1898.)

In an article by E. Berger, we find 67 cases of splenectomy for ruptures, with a mortality of 43·3 per cent. The author has collected 127 cases of laparotomy for ruptures and wounds of the spleen, in which the general mortality is 41 per cent, and the mortality of 80 splenectomies 43·7 per cent. It is to be noted that here again the coexistence of other visceral lesions makes the prognosis more serious; the mortality rose to 51 per cent for the complicated cases, and fell to 34·6 per cent. in the uncomplicated cases. (E. Berger, "Die Verletzungen der Milz und ihre chirurgische Behandlung." *Archiv. fur klin. Chir.*, Bd. lxviii., Heft 3, p. 768, and Heft 4, p. 865.)

[1] It may happen that the spleen is almost completely detached, or a large segment may be found free in the midst of the effused blood.

packing are the only other resources : but they are simply makeshifts and of very doubtful issue.[1]

When the rupture is comparatively shallow, of limited extent and easily accessible, an attempt may be made to suture it and so check the bleeding, following the example of Luigi Lamarchia.[2]

His case was that of a lad, 15 years of age, who, half an hour previously, had received a violent blow with the fist in the left hypochondrium, and who presented all the signs of serious internal hæmorrhage. Median laparotomy was immediately performed : about two pints of blood escaped from the wound, and to see clearly the incision had to be extended by a lateral cut at the level of the umbilicus. A rupture of the spleen was found, commencing on the inner surface, crossing the anterior border, and extending for about an inch on to the convex outer surface ; it was more than half an inch in depth at the anterior border, and was still bleeding profusely. The fissure was closed by a number of deep silk sutures, entering and emerging at half an inch from the margins on either side and penetrating deeply into the tissue of the organ, and some superficial sutures. The bleeding ceased and the abdomen was closed. However, the patient died an hour and a half after the operation, and at the post-mortem examination a vertical fissure nearly two inches long and half an inch in depth was found on the portion of the inner surface of the spleen lying behind the gastro-splenic omentum. The suture of the anterior wound had held perfectly.

On the whole the case is not very encouraging,[3] and in similar conditions of a limited, comparatively superficial rupture, when suture is difficult and the parenchyma is friable, successful results may be obtained by careful packing, as is shown by a case reported by Loison.[4]

However, splenectomy remains the method of choice except under very unusual circumstances.

[1] With regard to the isolated ligature of the splenic vessels corresponding to the ruptured segment, the division of the spleen into non-communicating vascular territories gives exceptional chances of success to this method, but at the same times causes a danger of a secondary complication : necrosis of the segment deprived of its blood supply. (See Vanverts, *De la splénectomie*. Thèse de doct., 1897, pp. 40 and 140.)

[2] L. Lamarchia. *Centralblatt f. Chirurgie*. 11 Jan., 1896.

[3] If suture is adopted it is necessary to use thick threads introduced with a round-bodied needle and tied very gently. The splenic tissue is even more friable than that of the liver : in some cases, however, where there is old-standing perisplenitis, the thickened and sclerosed capsule is more resistant and may offer adequate support for the sutures. In a young woman of nineteen years operated on by Rehn five hours after an accident, there were three ruptures of the stomach, one of them being perforating, and on the spleen a fissure about two inches long : the lower pole of the organ was also crushed and stripped of its capsule. The splenic fissure was sutured, and the bleeding from the damaged lower pole checked by means of the thermo-cautery. Drainage. Recovery. ("Die Verletzungen des Magens durch stumpfe Gewalt." *Arch. f. klin. Chir.*, Bd. liii., 383.)

[4] The patient had received a kick from a horse on the anterior part of the left hypochondrium, and laparotomy was performed twenty-four hours after the accident. After the evacuation of a large quantity of dark blood which filled the left hypochondriac region and had run down into the pelvis, a tear of the spleen, about an inch in length, dividing the upper pole of the organ in the frontal plane, was found. The lesions did not appear sufficient to justify splenectomy. A large plug composed of several folds of aseptic gauze enveloped in a layer of iodoform gauze was packed in between the diaphragm and the upper part of the spleen, the outer extremity emerging from the upper angle of the abdominal incision. The plug was removed on the fifth day. Recovery. (Loison. "Rupture traumatique de la rate. Laparotomie. Tamponnement. Guérison." *Soc. de chir.*, 23 jan., 1901, p. 40.)

2. **Wounds of the Spleen.**—Here, in addition to the possibility of internal hæmorrhage, profuse bleeding through the external wound sometimes occurs, and, following the principles for which we have already pleaded, the single fact of the existence of a *penetrating wound* constitutes a major indication for immediate operation.

Of course a timid enlargement of the external wound cannot be expected to give easy access and to permit adequate exploration and the necessary hæmostatic manœuvres, any more than when dealing with the intestine or liver. A median abdominal incision should always be made first unless the situation and direction of the wound seem to point very definitely to a splenic lesion, when lateral laparotomy by means of the incision at the outer border of the rectus, figured already (*Figs. 322, 323, 324*) may advantageously be adopted.

But the wound sometimes occupies *the postero-lateral aspect of the trunk or the upper lumbar region*, and injuries of that type may involve, along with the spleen, the kidney, the diaphragm, or the left lobe of the liver. The operation in such cases will always follow certain definite lines: preliminary enlargement of the wound, and exploration of the focus of injury. Should it then be discovered that the kidney is not alone affected, but that the peritoneal cavity is opened and blood continues to flow from the depths, laparotomy will be at once performed without wasting time over any doubtful indirect measures, after having packed the lumbar wound; or, again, by means of a transverse incision immediately below the costal margin, joining the enlarged primary wound posteriorly, a lateral way may be opened: this is a very natural practice, but does not provide as much room as a free laparotomy.

The rest of the operation will be conducted as before: digital compression, replaced by clamping, of the splenic pedicle, rapid removal of blood and clots, extraction and extirpation of the spleen.

Splenectomy is demanded, in fact, in all cases of extensive laceration of the organ: the operation can and ought to be very rapidly performed.[1] Fissures or superficial erosions, or some bullet wounds, are the only injuries suitable for treatment by suture.[2] With regard to packing, here as elsewhere it is only to be used when other more efficacious measures are impracticable.

Traumatic Hernia.—In some cases of large wounds in the left hypochondrium or left flank, it happens that the spleen is protruded,

[1] But even the greatest promptitude cannot always save the patient. A young man, aged 22 years, had shot himself with a revolver in the chest at the level of the 7th left intercostal space at 7.30 p.m. He was at once taken to the Hôtel Dieu, where Morestin operated on him at 8.30: the wound of entry was enlarged, and it was found that the diaphragm was perforated: an incision was made parallel to the left costal margin: an enormous quantity of blood gushed from the abdomen: the spleen was searched for: it was found to be cut in two: the pedicle was tied and the organ removed. The operation had only lasted a quarter of an hour: but the loss of blood had already been too great: the patient never recovered consciousness, and succumbed some hours later. (Morestin, "Plaie de la rate par coup de feu. Splénectomie. Mort." *Soc. anat.*, 7 oct., 1898.)

[2] Suture has twice been performed for bullet wounds, with one death: and ten times for wounds produced with sharp instruments without a death, but the wounds were small and not very serious. (E. Berger, *loc. cit.*)

partially or completely, through the parietal opening. Vanverts has collected 29 cases, of which, however, only 6 have occurred during the last 25 years. If the protruding organ is also wounded and bleeding, there can be no doubt as to the proper course to pursue: **it must be removed,**[1] and one might say that the operation is already half done.[2]

If it is intact, if the surface is smooth and healthy, and the protrusion is quite recent, the organ will first of all be carefully cleansed with gauze swabs moistened with warm saline solution; the wound will then be enlarged, the pedicle and the surrounding region carefully examined, and if there appears to be no reason against it, *reposition* will be practised and the abdominal wall closed.

Naturally this plan cannot be adopted when the protrusion has existed for some time, when the protruded portion is strangulated, dusky in colour, and flaccid. Under such conditions reposition is not to be thought of; the best plan is to excise the portion becoming gangrenous with the thermo-cautery, or, after ligation of the base, to cut it away with knife or scissors. Care must be taken to fix the stump to the wall by a few sutures. When the whole spleen lies outside the parieties and is in this condition, the only treatment consists in *complete removal*.[3]

Wounds and Ruptures of the Pancreas.

It is now recognized that injuries of the pancreas are more common than was formerly believed: they may occur alone or in association with other lesions of the surrounding viscera: the liver, the spleen, the stomach, or the intestine. They are most often due to penetrating wounds or blows affecting the epigastric region: it is therefore always advisable to keep the possibility in mind after an accident of that kind. The organ may, however, also be injured from behind; in the case of Ninni's patient, a revolver bullet had entered quite close to the second lumbar vertebra, traversed the first lumbar vertebra, produced six perforations in the small gut and another in the colon near the hepatic flexure, and finally emerged in the right of the epigastrium. Laparotomy was performed, the seven intestinal perforations were found and sutured; and then, as blood was seen to be escaping from between the stomach and transverse colon, the gastro-colic omentum was opened and a wound of the pancreas at the junction of the head and body was discovered: two deep sutures were introduced and stopped the bleeding, and drainage was provided. The patient was cured in five weeks. As a practical rule, when operating for injuries of the supra-umbilical region of the abdomen, an exploration of the pancreas

[1] Let us add: it must be removed, entire even if the protrusion is only partial, otherwise it will be necessary first of all to undertake a hæmostatic task, the difficulties and dangers of which we have already seen.

[2] Naturally any enlargements will be made of the parietal wound necessary for delivering the entire organ without tearing, and for proper examination and ligation of the pedicle. The prognosis of splenectomy in these conditions appears to be very good.

[3] See further on, Acute Conditions due to the Torsion of Pedicles, for torsion of the splenic pedicle.

should never be omitted; we shall see shortly by what routes the examination can be made.

But it may happen that the wounds or ruptures of the pancreas exist alone. In the case of a wound the single fact of penetration demands operation; in cases of ruptures the clinical situation, in the absence of vomiting or signs of internal hæmorrhage, may at first be uncertain; but rigidity of the epigastric wall, the steadily increasing pain in the same region, sometimes the detection of a deep-seated rounded swelling, constitute quite sufficient data, if not to support a definite diagnosis, at least to indicate the necessity for immediate operation.

A man 34 years of age was caught in a fall of earth; he felt an intense pain in the epigastrium; this pain increased steadily, the abdominal wall became rigid, and vomiting supervened; therefore, although the pulse remained strong and regular, and there were no signs of internal hæmorrhage, an intra-abdominal traumatic lesion was diagnosed. Four hours later the abdomen was opened; a little fluid blood was found in the peritoneal cavity, apparently coming from above; the liver, the spleen, the stomach, and the intestines were examined and found to be uninjured; finally a longitudinal tear was found in the gastro-hepatic omentum, through which the pancreas was seen, divided in two in the middle line by a vertical rupture; once the clots were removed, abundant oozing began from both lips of the wound, which was closed by six sutures of heavy catgut including the whole thickness of the gland. A drainage tube and a strip of gauze were placed in contact with the suture line, and the ends brought out through an opening made in the gastro-colic omentum, below the great curvature; the laceration in the small omentum was sutured. The drainage track continued for two months to discharge an alkaline fluid which gave the pancreatic reactions, then the fistula closed and the patient made a complete recovery.[1]

Operative Technique.—How is a wound or rupture of the pancreas to be exposed, and when exposed, how is it to be dealt with?

Let us first remember that sometimes during the course of the intra-abdominal investigations associated with an emergency laparotomy, the operator is led to the pancreas or rather to the supra- or retro-gastric region, by following a stream of blood which comes from above, and usually in such circumstances on raising the liver a tear of variable size is found in the gastro-hepatic omentum.

That is further the best way of access; the pancreas is most easily reached through an opening in the gastro-hepatic omentum made at a spot free from vessels, and it is by that route that exploration is most conveniently carried out in the doubtful cases. The gland may also be exposed below the great curvature, by an opening made in the gastro-colic omentum; or even, after raising the great omentum and the transverse colon, through the transverse meso-colon (in the same manner as in performing gastro-

[1] H. Heineke, "Ueber Pancreasrupturen." *Archiv f. klin. Chir.*, 1907, lxxxiv., 4, p. 1112.

enterostomy); but up to the present, experience has shown that the first route, through the gastro-hepatic omentum, is the best.

What is to be done when, after having emptied the lesser sac of blood and clots, a traumatic lesion—bullet wound, stab wound, rupture, or crush—of the pancreas is discovered? Even when the pancreatic solution of continuity is of limited extent and bleeding but little, and still more if the lesion completely divides the gland, hæmostatic suture is the best procedure:

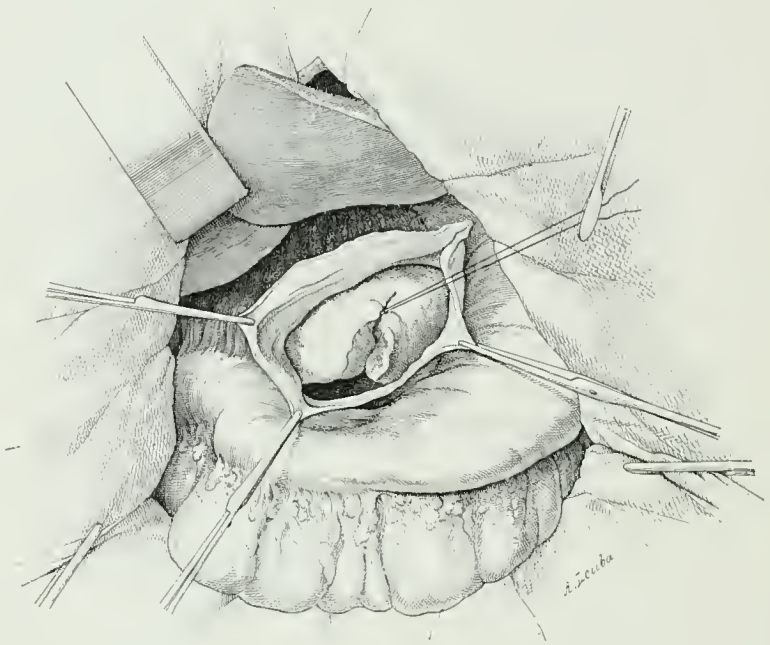

Fig. 326.—Rupture of the pancreas. Exposure of the organ through the gastro-hepatic omentum, pancreatic suture.

from one edge of the wound to the other, from one side to the other of a rupture, a series of interrupted sutures of heavy catgut is passed deeply through the thickness of the pancreatic tissue[1] (*Fig.* 326); after they are tied, complete adjustment of the edges may be effected if needed by some superficial capsular sutures. It is expedient to tie the sutures slowly and steadily, just tight enough to avoid risk of tearing or the well-known danger

[1] Or at any rate by picking up with the needle a sufficient thickness of the pancreatic tissue to give a good hold for the sutures and to be able to bring the borders of the wound into contact, the thickness varying naturally according to the degree of separation of the edges and the amount of traction required. This plan was followed in the first case of isolated rupture of the pancreas cured by operation. M. Garré having discovered a complete division of the gland, a little to the left of the vertebral column, brought the two portions together by three posterior sutures, and three or four anterior ones, passed practically through the capsule only: the hæmorrhage ceased. (Garrè, "Totaler Querriss des Pankreas durch Naht geheilt." *Beitrage zur klin. Chir.*, 1905, xlvi. 1. p. 233.).

of pancreatic necrosis. Of course, if the suture of the wound does not suffice to stop the bleeding, it would be necessary to apply forceps to and then ligate any troublesome bleeding points.

Drainage is always necessary, even after the most satisfactory suture;[1] a tube surrounded by one or two strips of gauze is placed in front of the pancreas, and the best plan is to bring the other end of the drain out through an opening made in the gastro-colic omentum below the great curvature of the stomach, and to suture the gastro-hepatic omentum.

If the wound is ill-adapted for suture, if it is bleeding but little, if the borders are contused and lacerated, it will be best to pack it: the end of the strip of gauze will be carried right to the bottom of the pancreatic wound and packed in with moderate firmness. In this way bleeding will be checked and the intra-peritoneal effusion of pancreatic fluid prevented.[2]

Lastly, in the event of a complete rupture of the tail of the pancreas, implicating the splenic vessels, leaving beyond it only a small crushed mass of gland, certain to undergo necrosis, the complete removal of the detached portion is always indicated.[3]

INJURIES OF THE LUMBAR REGION.

RUPTURES AND WOUNDS OF THE KIDNEY.

The kidneys may be injured by various routes, and their traumatic lesions are often associated with those of other abdominal viscera, intestine, liver, or spleen: such complications greatly increase the gravity of the renal lesions and add very much to the difficulties of operation.

In 200 cases of renal contusion, Tuffier[4] found 23 ruptures of the liver, 11 ruptures of the spleen, 1 contusion of pancreas, stomach, and intestine,

[1] Experience has shown that leakage of pancreatic fluid always occurs. The intra-peritonitic lesions which may thereby be produced are well known. When the pancreatic fistula is slow in closing, it will be well to try an anti-diabetic régime, combined with the administration of small doses of bicarbonate of soda (Wohlgemuth).

[2] Mention must also be made of the hæmorrhagic cysts of the lesser peritoneal sac which follow some pancreatic ruptures; for instance, take the following case. A man had been knocked down by a wagon, one of the wheels of which passed over the left side of his chest. Eleven days later a large fluctuating swelling, with well-defined limits below and to the right, was detected in the left flank and hypochondrium: an incision was made along the costal margin, and on raising the stomach after having opened the gastro-colic omentum, the blue-red wall of a cyst was discovered; the cyst was incised and two pints of hæmorrhagic fluid were evacuated: two drainage tubes were left in the cavity. Recovery ensued in two and a half months. The hæmorrhagic contents of the cyst gave the majority of the reactions of pancreatic juice (Heineke, *loc. cit.*)

[3] M. Robert Picqué thus removed an almost completely detached segment, as large as a hen's egg, of the body of the pancreas. The patient, a boy of thirteen years of age, had been thrown from his bicycle and had received a blow in the epigastric region: operation was undertaken on the sixth day because of symptoms of peritonitis. Between the liver and the stomach a cavity was found from which an opaque fluid escaped, and at the bottom of the cavity in front of the vertebral column the mass above mentioned was felt: it was almost completely detached, and was removed after division of a narrow band of tissue and ligation of a small artery. The cavity was packed. A profuse discharge of pancreatic fluid continued for three weeks, and was followed by a fistula, which did not close until some weeks later. (Robert Picqué, "Contusion isolée du pancréas, pancréatotomie au sixième jour." Rapport de Guinard. *Soc. de chir.*, 3 juin, 1908.)

[4] Tuffier, *Arch. gén. de méd.*, 1888, t. xxii., pp. 591 and 697: 1889, t. xxiii., p. 335.

2 contusions of bladder and lung, 1 rupture of the pleura, 15 fractures of ribs, 14 fractures of the limb bones, 4 fractures of the pelvis, 4 fractures of the vertebral column. Approximately complicating lesions were present in 20 per cent of the cases. Further, in 113 uncomplicated lacerations of the kidney, there were 49 deaths, that is 43 per cent; and in 55 complicated cases, 48 deaths, or 87 per cent. The knowledge of the frequent co-existence of complicating lesions is therefore an important practical point which applies to the two principal types of traumatic renal lesions: **contusions** and **wounds.**

Contusions.—It must be recognized that in the great majority of renal contusions the appearance of urgent conditions demanding immediate operation is comparatively uncommon; it is nevertheless impossible, without incurring considerable risk, to make primary abstention the general rule; a fact which has been demonstrated to many surgeons by personal experience.

1. **Mild Cases.**—A man has been knocked down by a carriage, and in falling his left side has come in violent contact with the edge of the pavement: he loses consciousness, and when seen a few minutes later is in a well-marked state of shock, with pallid face, feeble pulse, and laboured respiration. He gradually recovers, and at the end of an hour the pulse, though still rather quick, is much stronger, the skin has become warm, and the face is better; he still experiences acute pain in the left lumbar region and left flank, and at the first micturition he passes almost pure blood.

However, palpation of the flank, which is rendered very difficult by the pain, reveals no definite swelling, and the rest of the abdomen is soft and free from pain. And although blood is still passed per urethram, there is no alteration for the worse in the general condition during the hours immediately succeeding the injury; the temperature remains normal and the pulse good.

A slight contusion of the kidney with moderate hæmorrhage, in itself causing no immediate danger, is the apparent diagnosis. And as a matter of fact, the pain usually persists and the urine contains blood for a few days, then all symptoms gradually disappear and the patient makes an uncomplicated recovery.

Spontaneous cure of injuries of this kind may be confidently expected: rest in bed, the envelopment of the abdomen with a thick layer of cotton-wool secured by a firmly-applied flannel binder, milk diet, the administration of urinary antiseptics, salol, etc., form the bases of a reasonable method of treatment which will often give excellent results.

2. **Profuse Hæmaturia, Rapid Development of a Swelling in the Renal Region.**—The situation is somewhat different when the evident intensity of the injury, the amount of the hæmaturia, and the rapid development of a "renal swelling," even apart from any signs of serious internal hæmorrhage, indicate extensive lesions of the kidney. The following case

will serve as an illustration and provide a basis for discussing the indications, which are often difficult to define clearly.

A strong healthy man about thirty years of age received the full force of a kick from a horse in the left flank. He was carried home in a very alarming condition, almost pulseless and scarcely breathing, and it was only with the greatest difficulty that his medical attendant succeeded in bringing him round. But his general condition was so grave that no doubt was felt about the existence of a visceral lesion, and surgical assistance was sent for in haste.

I saw the patient about five hours after the accident. His condition had greatly improved : the face was good and well coloured, speech and respiration were easy, the pulse was strong, and the temperature 98·6° ; there had been no vomiting, and flatus had been passed by the bowel. Previous catheterization had obtained nothing but small quantities of almost pure blood ; the catheter was again passed ; the first portion of fluid withdrawn was thick and red, but soon became clearer, and finally presented the characters of normal urine. The patient still complained of very severe pain in the left flank and hypochondrium, but in those regions only, indicating very definitely the painful area ; the rest of the abdomen was free from pain, perfectly soft ; there was no unusual dullness, and deep palpation detected nothing abnormal. The left flank, however, in its upper part was tense and the wall hardened on the slightest touch ; however, by gentle examination I succeeded at length in determining the existence of a deep-seated swelling, but which only descended about two inches below the false ribs, and did not extend to the iliac fossa. I may add that there were no signs of any pleuro-pulmonary lesion.

Contusion and rupture, probably rather extensive, of the left kidney, perirenal hæmatoma : such was the diagnosis. What was to be done ?

It was apparent that there were no lesions of any of the intraperitoneal viscera : the emission of flatus, the results of palpation, all proved that point. There were therefore no indications whatever for an exploratory laparotomy, and if any operation at all was necessary, it must be directed to the left lumbar region. But what reasons were there for any such action ? The hæmaturia was very moderate, the state of the pulse, etc., indicated that no serious internal hæmorrhage had occurred, and hæmostasis seemed to be assured.

I therefore abstained from any immediate operation ; and this is what happened. The hæmaturia continued for some days, but in no very great quantity, and the general condition remained satisfactory. But towards the fifth day the temperature rose to 100·4°, 101°, 102°, and gradually the swelling in the flank enlarged, while remaining very hard in consistence. Because of the persistent fever an incision was made ; it opened a *very large perirenal cavity*, from which a considerable quantity of blackish fluid, composed of blood, urine, and pus, escaped ; the walls of the cavity were lined with greyish, sloughy membrane closely resembling that seen in cases of diffuse cellulitis ; in front *the posterior wall of the descending colon, infiltrated and friable, was exposed* in the wall of the abscess. Two days later a *fæcal fistula* developed, and although the patient ultimately recovered,

there can be no doubt that a primary operation would have been infinitely preferable. The secondary incision and the drainage of the focus were undertaken too late, and the ulceration of the wall of the large intestine was to a great extent due to the prolonged contact with the septic contents of the cavity.

The evolution of this case is most instructive: it shows very definitely the ordinary course of events in such conditions and how the indications should have been interpreted.

There were no signs of any hæmorrhage in such amount as in itself to cause alarm, but from the first **a swelling had been present in the flank and lumbar region**, which, together with the **hæmaturia** and the undoubted violence of the injury, left no doubt of the existence of a rupture of the kidney.

The best plan, in my opinion, is to operate as soon as possible, to open up the focus of injury, stop any bleeding, and so prevent the development of septic complications. At any rate, if conditions of place, etc., prevent the carrying out of this programme, the patient should be kept quietly in bed on his back, with the flank compressed by the aid of a large pad of wool and a broad flannel binder, and the temperature be closely watched; should any characteristic fever[1] develop, then operation must be undertaken without delay.

A perirenal hæmatoma may be absorbed,[2] but only if it is and remains aseptic,[3] and this condition is by no means always realized. Symptoms are sometimes slow in appearing, leading one to believe that the case is going to run a favourable course; then, from the sixth to the seventh day, sometimes later still, they may burst forth; the swelling enlarges, the temperature rises, the general condition alters for the worse, and finally operation becomes absolutely necessary under much greater difficulties and with less chance of success than in the early days. These perinephritic abscesses consecutive to a laceration of the kidney are not simple hæmatic abscesses, accumulations of variable size but well circumscribed, easily opened and cleansed, and to be readily cured by simple incision and drainage. On the contrary, they are in the great majority of cases *urinary abscesses*, and the case we have quoted above shows their tendencies and dangers very well.

Again, it is a mistake to think that positive hæmostasis may be

[1] A moderate rise of temperature during the first few days is not a certain sign of infection, such febrile movements, which are indeed sometimes quite considerable, may be observed after any large effusion of blood (hæmothorax, pelvic hæmatocele, etc.).

[2] A special place must be accorded to those urino-sanguineous effusions to which Tuffier has drawn attention, and which imply a simultaneous rupture of the kidney and pelvis or ureter. Owing to the escape of both blood and urine, they increase very rapidly during the first few days and acquire a very considerable size: towards the tenth day "the hæmaturia generally reappears and the swelling diminishes," the accumulation of urine and blood empties itself by way of the renal pelvis, and recovery ensues in from a month and a half to two months—if there has been no infection. (See Tuffier et Levi, "Epanchements uro-hématiques périrénaux par contusion du rein." *Presse médicale*, 1895, p. 153, and A. Dordonnat, Thèse de doct., 1896.)

[3] It must not be forgotten that *careless catheterization is often the starting point of ascending infection of the perirenal focus.*

assured by waiting before opening the hæmatoma: a case reported by M. Peyrot[1] demonstrates the contrary very strikingly.

It related to a bricklayer who fell from a scaffolding, his left side coming in contact with a heap of building stone. The symptoms at first were quite mild, and at the end of a fortnight the patient was sent to the country. He was re-admitted to hospital a month and a half after his accident: "the left side was swollen, reddened, and tender on pressure; percussion revealed an area of dullness which extended upwards as high as the sixth intercostal space, downwards to the iliac crest, and transversely to the opposite side of the body three inches to the right of the umbilicus. On palpating this huge swelling a sensation of deep fluctuation, particularly at its antero-internal part, was detected." Operation was performed, and the incision, extending from the middle of the 12th rib to the iliac crest, opened at once into a large cavity. "It was full of clots, which I commenced to remove with the hand. While I was doing this some *bright red blood began to escape, and soon gushed forth profusely from the bottom of the cavity.* I immediately carried my fist to the bottom of the pocket to apply pressure to the area where the kidney ought to be, while my assistant, M. Bazy, at my request rapidly enlarged the wound for a couple of inches downwards along the crest of the ilium. Then, using both hands, the cavity was rapidly emptied of all the clots; a sponge removed what remained, and *I then perceived two or three large vessels from each of which a large jet of blood was escaping.* Three clamps were placed on the spouting vessels and the bleeding ceased. It was then discovered that the vessels were in the upper part of the kidney. The organ itself, which was flattened and almost unrecognizable, lay in the postero-internal and lower part of the cavity. It seemed therefore to be considerably displaced in a downward direction, and the rupture was situated in its upper portion. The forceps were left in position. . . ." The patient recovered.

To conclude, in the case of a ruptured kidney with a rapidly formed and large hæmatoma, although operation is not urgent in the strict sense of the word, there will generally be a decided advantage in performing it early, for it will then be less dangerous and less difficult.

3. **Dangerous Hæmorrhage.**—Sometimes the amount of the hæmorrhage demands immediate operative measures, whether it expresses itself by profuse and persistent hæmaturia or in the form of a huge swelling in the lumbo-abdominal region associated with the signs of acute and progressive anæmia. It is to be noted, however, that, excluding the exceptional cases of rupture of the renal artery or vein, and those in which there is a simultaneous rupture of the peritoneum, these *retroperitoneal hæmorrhages* do not follow the rapidly fatal course associated with similar intraperitoneal conditions; it is usually after some hours, or on the day following the accident, therefore, that the signs of loss of blood become sufficiently grave to command immediate operation.

In one of Tuffier's patients, on the morning after the accident there

[1] *Bull. de la Soc. de Chir.*, 21 mars, 1894.

was "an enormous swelling in the space between the ribs and the crest of the ilium, and extending into the abdominal and lumbar regions. Posteriorly the prominence was great enough to make the spinous processes appear depressed. . . . The urine contained red blood. There was paresis of the corresponding lower extremity, and the patient complained of tingling pains in both lower limbs. A large lumbar incision opened a double cavity filled with clots; one pocket was subcutaneous, the other deep, the two communicating through a rupture in the erector spinæ muscles; *on the posterior surface of the kidney there was a rupture two inches long from which arterial blood was escaping*; the transverse process of the 1st lumbar vertebra and the 12th rib were fractured. It was also on the day after the accident that in the case of a patient of Lucas-Championnière, the symptoms of internal hæmorrhage became pronounced, and operation was performed; the quantity of extravasated blood amounted to at least two pints, and the kidney was found divided in two, with its upper part crushed.

It must not be forgotten that *the hæmaturia is not always in direct relation with the amount of the perirenal hæmorrhage*; it may even be absent or very limited in cases where the kidney is completely ruptured or crushed, those cases indeed in which the internal hæmorrhage is greatest.

TECHNIQUE OF OPERATION.

Whether the operation be undertaken immediately after the injury or after a variable delay, it will be performed by the **lumbar route.**

Median laparotomy is only indicated in cases where there is reason for suspecting the existence of an intraperitoneal effusion and associated lesions of abdominal viscera, perhaps also in children, in whom the posterior portion of the parietal peritoneum is backed by so little fatty tissue that it often ruptures along with the kidney.[1] *The para-abdominal route* is not at all applicable to these cases; it does not give sufficient access to the renal pedicle.

Have the patient placed on the sound side, with a pillow under the flank, and the thigh on the injured side moderately flexed.

Make **a very large incision** at once; it is impossible to have too free access to the depths of the space, particularly in fat subjects, and providing sufficient room from the beginning will eventually save much time—and blood.

[1] *Intra-peritoneal rupture* is very rare in the adult. Sonligoux has, however, reported a very instructive case: contusion of the lumbo-abdominal region caused by the oblique passage of the wheels of a cart over the body; bloody urine mixed with elongated clots of a dark red colour; blackish vomiting; bad pulse; abdomen distended and painful, particularly in the right flank. Median laparotomy five hours after the accident: blood and urine were found in the abdomen, but no lesion of any intra-peritoneal organ; the blood came from the right renal region, and the right kidney was felt to be torn. Two large drainage tubes surrounded by gauze were placed in the wound. The urine to a considerable extent passed through the anterior wound, and a transperitoneal urinary fistula persisted. On the fourteenth day secondary nephrectomy was performed through a lumbar incision, the crushed organ being enucleated from within the capsule and removed. Recovery. (Fossard, *Soc. anat.*, 13 avril, 1900, p. 399.)

Find the 12th rib, and then rapidly follow, with the finger, the line of the spinous processes, the outer border of the erector spinæ muscle and the iliac crest.

The incision will begin at the middle of the 12th rib and descend obliquely to the iliac crest, which it will join at, or a little in front of, the mid-point (*Fig.* 327). If necessary prolong the incision along the crest nearly to the anterior superior spine.

The skin, the posterior fibres of the external oblique, and the internal oblique have to be traversed, and the aponeurosis of the transversalis where it splits into two layers to enclose the quadratus lumborum muscle. In traversing the wall two principal landmarks present themselves: *the outer border of the quadratus lumborum*, which must first be exposed, *then the yellow perirenal fat*, which is encountered immediately after dividing a thin aponeurotic layer (*Fig.* 328) lying below the quadratus muscle.

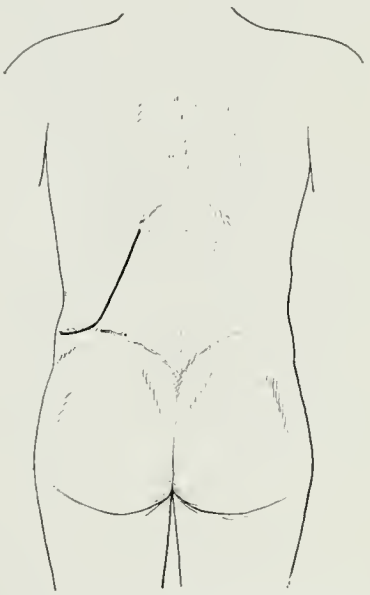

Fig. 327.—Lumbar incision for exposure of the kidney. In front it is prolonged along the crest of the ilium.

In operations performed for rupture of the kidney, the preliminary steps are usually simpler than under ordinary conditions; nearly always the subcutaneous and muscular planes are infiltrated with blood, or an accumulation of blood lying superficially may be met which communicates deeply with the perirenal effusion; even apart from this, as soon as the skin and the first musculo-aponeurotic layers have been divided, a tense, fluctuating, blackish wall bulges into the bottom of the wound and offers itself to the knife. Open this, but be ready to deal with what may follow. A large stream of blood will escape from the wound as soon as the swelling is opened, and if a great vessel has been involved in the rupture, bright red blood will continue to gush out from the depths. Such an occurrence must be expected, and the surgeon should be ready to do what is necessary. A useful precaution, if a good assistant is present, consists in making him compress the abdominal aorta through the abdominal wall with the closed fist; the assistant's hand may also be a help at a later stage in pushing the kidney or its fragments into the wound, and so rendering it more easily accessible.

Once the perirenal focus is incised, the further steps of the operation will vary according to the nature of the lesions.

1. **Vascular Ruptures.—Hæmostasis.**—One or more vessels of some size are torn, and arterial blood flows profusely from the depths of the wound.

Immediately carry the finger, the hand, or the closed fist towards the bleeding area, towards the renal pedicle or the aorta if necessary, and compress the whole area en masse. This is a manœuvre which requires coolness and energy. With the other hand clear the cavity of clots and swab up the effused blood. Then raise the compressing hand gradually, sponging continuously all the time, and, with the edges of the wound widely retracted, ascertain whence the blood comes, and apply forceps to the bleeding vessel. If temporary hæmostasis has been adequately obtained by the fingers at the bottom of the wound, and particularly if, after the first alarm has passed and the cavity has been cleared of blood and clots, one has been able to recognize the position of the kidney and to slip one's fingers on

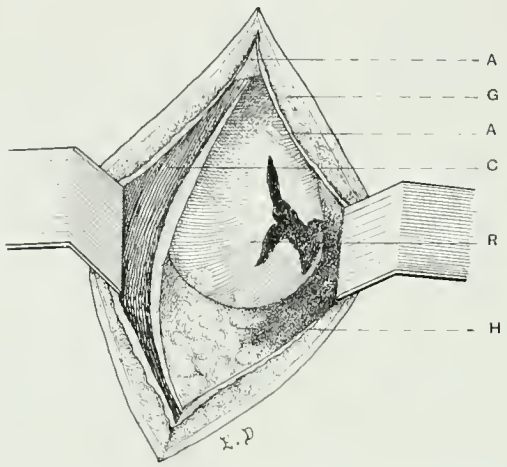

Fig. 328.—Lumbar incision: the injured kidney exposed. (AA') Aponeurosis (superficial layer). (G) Subcutaneous fatty tissue. (C) Quadratus lumborum muscle; below it the deep aponeurotic layer can be seen. (R) Lower pole of the kidney, extensively lacerated. (H) Perirenal fat, infiltrated with blood.

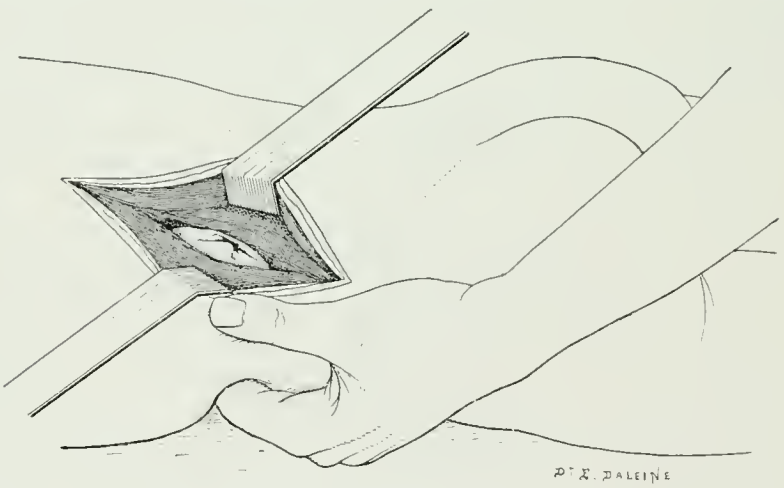

Fig. 329.—Pushing the kidney up into the lumbar wound.

to the pedicle, there should be no danger of causing irreparable lesions by applying clamps to the wall of the aorta or the vena cava.

Under these circumstances no rule can be laid down except this:

apply forceps to the bleeding points and always go to the pedicle; work inwards towards the vertebral column, in order to compress the pedicle or clamp it if itself injured, or if, in view of the impossibility of controlling the bleeding by other means, it is necessary to sacrifice the kidney.

Bleeding having been checked by the application of the clamps, the condition of the kidney must be determined, and to do this, the plan of pushing the organ up into the lumbar wound, shown in *Fig.* 329, is very useful. If it is crushed or completely divided, then nephrectomy will be necessary; if it can be preserved, the forceps will be replaced as far as possible by ligatures. The latter is often a very dangerous undertaking, and it may be better, instead of running the risk of fresh hæmorrhage, to leave the forceps in position, supporting them by packing the cavity with gauze.

It would be wrong, however, to exaggerate the frequency of these dangerous hæmorrhages due to injuries of the large vessels, for more often, after the perirenal accumulation has been evacuated, one has only to deal with an oozing, which may certainly be very profuse, but still causes no immediate danger.

2. **More or less extensive Rupture of the Kidney, but without complete Division or Crushing.**—A gaping, bleeding fissure of variable depth is found, usually on the posterior surface, about the middle, less frequently on the anterior surface (*Fig.* 330).

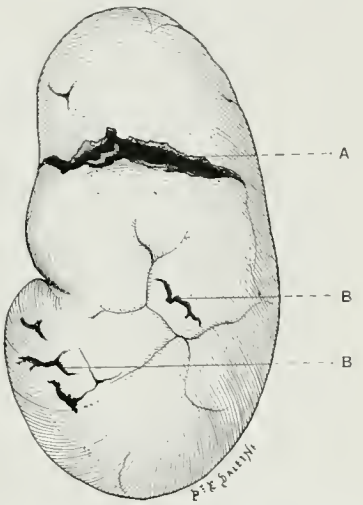

Fig. 330.—Transverse rupture of the upper part of the kidney. (A) Fissure with gaping edges. (BB') Superficial ruptures. (From P. Güterbock, Beiträge zur Lehre von Nierenverletzungen. *Arch. f. klin. Chir.*, 1895, Bd. li. 2, p. 257, *fig.* 4.)

In such a case the operator must endeavour to preserve the kidney; two methods are available for checking the bleeding: **suture** and **packing**.

Suture has given excellent results in Tuffier's hands. For its successful performance it is essential that the kidney should be sufficiently mobile to permit of its being properly exposed. As with the liver, the suture must pass deeply into the tissue of the organ.

Using a curved Reverdin needle and thick catgut or silk, a sufficient number of sutures are passed through the two lips of the wound at a distance of half or three-quarters of an inch from their borders; they should all be introduced before any are tied, and the tying must be done gently to avoid risk of the sutures cutting out. The method is identical with that employed after nephro-lithotomy (*Fig.* 331).

It is always advisable to reinforce the suture by packing; in certain conditions packing is the only method applicable, and is most conveniently done by Mickulicz' method.

3. **Complete Rupture or Crushing of the Kidney.**—The kidney is divided in two, completely ruptured from convex to concave border. What is to be done ?

Removal is usually the only feasible plan, particularly if the division is situated in the middle part of the organ and involves the pelvis extensively, and when, apart from the difficulty of controlling the bleeding in any other way, the preservation of the organ would be of no real benefit. But if the rupture has affected only one of the extremities of the organ without involving the central part and the hilum, it will be enough to remove the detached segment and *to check the bleeding from the ruptured surface of the portion left behind by mass ligatures or a series of perforating loops* arranged as in *Fig.* 332.

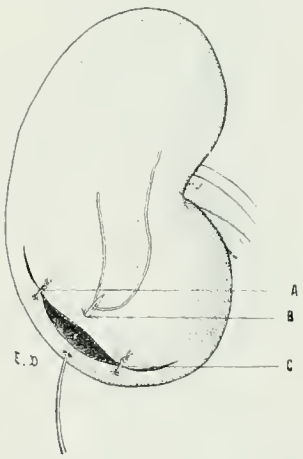

Fig. 331.—Suture of the kidney. (A, C) Two sutures at the extremities of the wound, already tied. (B) Introducing an intermediate suture.

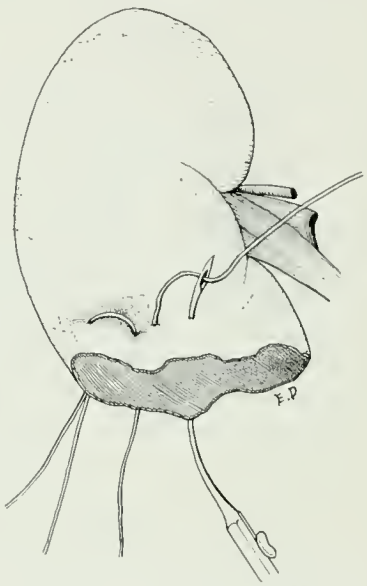

Fig. 332.—Renal hæmostasis by means of loop sutures passed through the whole thickness of the organ.

In a case of complete crushing, such as is represented by *Fig.* 333, complete removal is the only rational method of treatment ; nephrectomy is then a hæmostatic measure. It is a real " nephrectomy by morcellement," in the strict sense of the term, that the operator is called upon to perform in these cases, and a nephrectomy which should be, as far as possible, *subcapsular.*

Practically the organ is removed as follows : The renal capsule proper is already torn, and often largely stripped up at the margins of the fissures which separate the various segments of the gland. Taking advantage of this already existing decortication, remove the loose fragments ; now continue the separation of the capsule (*Fig.* 334), strip the organ to the hilum, and then draw it gently outwards ; you will then put a clamp, or two if necessary, one above and one below, on the vessels and the ureter, and proceed to cut the pedicle close to the hilum and a good half inch beyond

the clamps ;[1] the division of the pedicle should never be effected by a single cut, but by a series of small cuts from below upwards, and each vascular trunk should be seized with forceps as it is divided ; if it be necessary to clear the stump of the kidney out of the way as quickly as possible, still, as soon as the organ is removed, the cut surface of the pedicle should be gone over, and separate pressure-forceps applied to each vessel. This is the best means of guarding against the danger of the ligature slipping. A firm and carefully-tied ligature will now be substituted for the clamps.

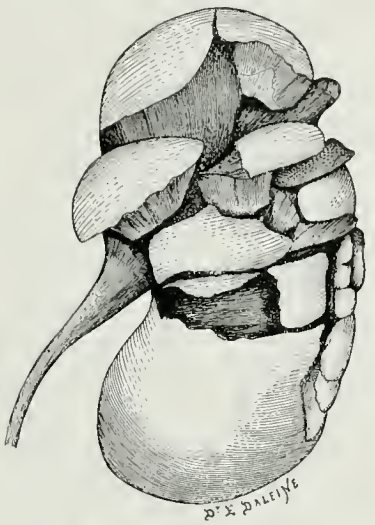

Fig. 333. Multiple ruptures of the kidney. (From the paper by P. GUTERBOCK, already quoted, p. 249, *fig.* 2.)

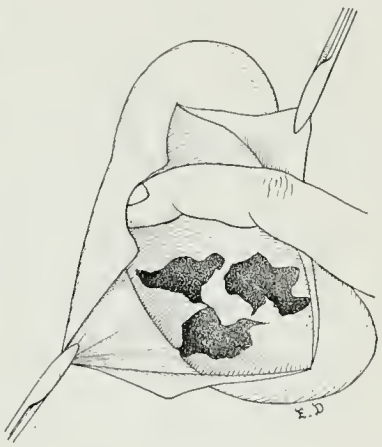

Fig. 334.—Subcapsular nephrectomy ; decortication of the injured kidney with the finger. The margins of the capsule are held with forceps ; the index finger is continuing the separation of the capsule. (Semi-diagrammatic.)

First look for the ureter below the vessels and tie it separately ;[2] then encircle the vascular pedicle with a loop of strong silk or No. 3 catgut, make a surgeon's knot, and tighten the ligature steadily and completely ; lastly, do not omit to apply, closer to the spine, another "security" ligature around the pedicle, and to tie the vessels in the face of the stump separately (*Fig.* 335).

Perfect hæmostasis is of vital importance, so devote the utmost attention to it, remembering that these renal pedicles are often friable and

[1] If the pedicle is long, comes up easily, and the bleeding is not troublesome, the ureter may be looked for first of all ; isolate it, divide it between two ligatures, and touch the two cut surfaces with the thermo-cautery. The vascular pedicle is now taken between the fingers of the left hand and perforated at the middle very carefully with a pedicle needle or a pair of pressure-forceps carrying two separate ligatures, which, after being interlocked, are tied, the one above and the other below ; finally, a security ligature is tied round the whole of the pedicle, which may then be divided without danger. However, owing to the need for giving oneself room, the bleeding, and also to the shortness of the pedicle, it is only rarely in these traumatic nephrectomies that this method is practicable, and as a rule it is best to make sure of the vessels with the clamps first of all.

[2] Do not omit to cauterize the cut surface and to destroy the mucosa of the distal end.

easily cut by a too sudden tightening of the ligatures, which must therefore be tied slowly and gently but withal firmly. Do not cut the ligatures until it is seen that they are holding perfectly, and that the pedicle, *after having been allowed to retract*, remains dry.

Wounds of the Kidney.—It is impossible to make the diagnosis of a renal lesion from the situation and depth of a lumbar wound: **hæmaturia** is the principal diagnostic sign, for the escape of urine by the wound is a quite exceptional occurrence unless the renal pelvis, the ureter or the calices are wounded. In addition there will be, varying in different cases, hæmorrhage from the wound or the symptoms of internal hæmorrhage, pain in the loin and flank, often radiating to the testicle, and the more or less rapid appearance of a perirenal swelling. In most cases, the examination of the patient—even in the first hours—will give, if not certain, at least very strong presumptive, evidence as to the nature of the condition. When dealing with a wound of the kidney, and particularly at the time when the first decision must be made, it is well to have some ideas drawn from experience and statistics with regard to the general character and prognosis of these injuries.

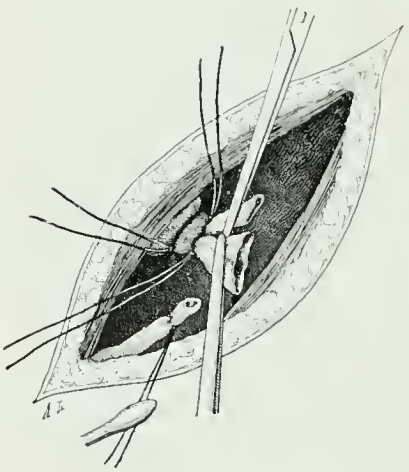

Fig. 335.—Ligature of the renal pedicle.

Apart from injuries of the great vessels in the hilum[1] or very extensive parenchymatous lesions, wounds of the kidney alone cannot in themselves be considered very serious, and indeed they usually heal readily.

Associated injuries of neighbouring organs, of the abdominal viscera in particular, add very considerably to the gravity of the prognosis.

Therefore, gunshot wounds of the kidney, and wounds inflicted by any other than the lumbar route, are very serious. Not only the prognosis but also the indications for treatment will be largely influenced by the existence of such conditions.

The indications therefore vary in practice according to the characters of the wound and the symptoms observed.

1. **If the wound is small,** a puncture from a stab with a stiletto for instance, or even a bullet wound if produced by a weapon of small calibre and low power (pocket pistol, toy rifle) and situated in the lumbar region, and if, as is almost constantly the case, *no serious symptoms* are present,

[1] We may also here mention, that very exceptionally the renal artery and veins alone may be involved, without any lesion of the kidney itself. (Thevenot, "Plaies et ruptures du pédicule vasculaire du rein." *Gazette des hôpitaux*, 17 jan., 1907, p. 75.)

then abstention from operation and close supervision is the best plan; the patient must be kept in bed on his back with an ice-bag applied to the flank, and the condition of the urine, the temperature, and the perirenal region will be closely watched.[1]

2. At other times the evident and immediate gravity of the symptoms may command operation. The symptoms which produce such urgent indications are **hæmorrhage from the wound**, the signs of **internal hæmorrhage** or **profuse hæmaturia**; when these appear it is almost invariably within the first few hours after the receipt of injury. It is better to operate by the ordinary lumbar incision made at the seat of election than by enlarging the primary wound and trying to follow the track of the injury; the latter method, unless the wound is of considerable size, is always difficult, and often gives very inadequate access. The remaining steps of the operation will be conducted as in dealing with ruptures of the kidney, and the operator must endeavour to combine, as far as possible, satisfactory hæmostasis with at least partial preservation of the damaged organ.[2]

3. The situation is much less definite in what may be called the **intermediate cases**. The patient has received a stab with a knife or a bullet wound in the lumbar region; he passes blood with the urine, and the rigidity and pain in the flank leave no doubt as to the existence of a renal injury; however there is nothing urgent in the symptoms, and the examination of the abdomen, which ought always to be made most carefully, reveals no pain, no distention, no suspicious dullness, nor are there any functional disturbances to indicate intraperitoneal penetration.

What are we to do? Shall we simply cleanse the external wound and wait; that is to follow the old practice, which, as we have already said, furnishes a fairly large proportion of successful results: it will be the prudent course in certain conditions, when we are able to keep the patient under close observation, and prepared to meet without delay any fresh symptoms which may arise.

But it will certainly be much better to enlarge the wound, open up the renal fossa, and explore the kidney; if no serious parenchymatous

[1] Operation will be performed by lumbar incision on the first signs of any secondary septic complications.

[2] As was done by M. Adenot, of Lyons, in a very interesting case where, however, cure was only obtained after numerous complications. Revolver bullet wound in the left side, the wound of entry being situated at the level of the eleventh rib; no immediate serious symptoms. Four hours later, the condition became suddenly worse: signs of acute anæmia, pulse very small and almost uncountable, extremities cold, dyspnœa. Operation at the seventh hour: posterior vertical incision, excision of the eleventh rib; in the parietal peritoneum a punched-out hole was found; it was enlarged, and a large cavity full of blackish clot was opened into; a large jet of venous blood escaped from the depths; the finger was placed on the bleeding point, the cavity cleansed with swabs, and a second orifice, whence the blood came, was then discovered on the anterior surface of the kidney leading into the ruptured parenchyma of the organ. The hæmorrhage was arrested by gauze packing. Thirteen days later the bullet was detected by radiography, situated comparatively superficially in the lumbar region: at operation it was found in the substance of the quadratus lumborum muscle, and removed. Grave symptoms of local infection developed, necessitating several secondary incisions for drainage, and persisted for five weeks. Ultimate recovery. (E. Adenot, "Plaie du rein gauche par coup de feu." *Gaz. des hôp.*, 1898, Nos. 95 and 96.)

lesions are found we may at any rate evacuate the effused blood and clots, cleanse the cavity, and pack it with gauze. In this way, complications will be prevented and convalescence hastened. And often in carrying out this truly surgical method of treatment, unsuspected lesions will be discovered which would have given no indications of their existence in the early stages, and which can be more satisfactorily remedied while the wound is still recent and non-infected. Finally, let us add that urgent intervention may be demanded at a relatively distant date because of secondary hæmorrhage or the symptoms of infection or urinary infiltration.

Wounds of the Renal Pelvis and of the Ureter.—Wounds of the pelvis of limited extent may be sutured. Fine catgut (No. 00) should be used in interrupted sutures, placed very close together and in two rows, a deep and a superficial; the deep sutures should exclude the mucous lining as far as possible; the superficial row should be applied like Lembert sutures, bringing a double fold of the route wall of the pelvis over the inner layer. Drainage is essential. If the lesion of the pelvis is extensive, nephrectomy will be needed; in most cases, indeed, where the pelvis is seriously damaged, there will be associated lesions of the kidney which would in themselves require the removal of the organ.

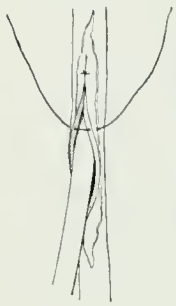

Fig. 336. *Fig.* 337.

Fig. 336.—Suture of a lateral wound of the ureter. (A fine bougie introduced into the canal supports the wall and facilitates the suturing).

Fig. 337.—Suture of a wound of the ureter. Suturing the peri-ureteral connective tissue sheath over the line of suture in the ureter.

Wounds of the ureters[1] require to be repaired at once; this is particularly the case when they occur as surgical injuries during the performance of abdomino-pelvic operations. The method of dealing with them varies according to the type and situation of the lesion.

If the lesion is a longitudinal wound, or an incomplete section of the

[1] Mention may here be made of the very uncommon subcutaneous ruptures of the ureter. Morris could find only two undoubted cases; in four others a lesion of the ureter was probable, and in five others where ureteric stenosis and hydronephrosis subsequently developed, the condition was possibly due to a pre-existing traumatic lesion. (*Edinburgh Medical Journal*, 1898.) M. O. Hildebrandt has published two cases: in the first there was a longitudinal rupture of the right ureter 1 cm. in length and situated ½ cm. above the vesical end; it was only discovered at the post-mortem examination, the patient having died during the operation. The case was one of multiple injuries caused by the passage of a vehicle over the trunk; because of the increasing hypogastric pain, inability to pass water, and the feeble pulse, it was supposed that there was a rupture of the bladder; the bladder was, however, found to be intact, and by following the track of the urinary infiltration backwards and to the right, a cavity filled with urine was discovered; death ensued before any further investigation could be made, and the actual injury was, as we have said, only discovered at the autopsy. ("Ueber einen Fall von Ureterriss." *Beitr. zur klin. Chir.*, Bd. xxxvii., 3, p. 782.) In the second case, the rupture of the ureter, which was associated with a laceration of the renal pelvis, had at first caused no serious symptoms; the patient, who had fallen from a considerable height on to his right side, suffered very little, and left hospital at the end of eight days. Then a swelling appeared in the right flank, and steadily increased in size; a diagnosis of traumatic hydronephrosis was made and operation performed. A paranephritic cyst containing about six pints of fluid was opened, and a fissure of the renal pelvis and a complete rupture of the ureter, 1 cm. below its origin, were found. The kidney was removed and the cavity packed. Recovery. ("Ruptur des Ureters." *Freie Vereinigung der Chirurgen Berlin's*, 10 Dec., 1904.)

tube, it must be closed by a series of interrupted sutures placed very close together and including the whole thickness of the wall with the exception of the mucosa; only a single layer of sutures should be introduced, in order to avoid too great narrowing of the canal (*Fig.* 336). The peri-ureteral connective tissues should then be brought together as far as possible around the line of suture (*Fig.* 337).

In the case of a total section, or a short excision affecting the ureter in its continuity at some distance from either extremity, the two ends must be joined together. But by what method?

End-to-end ureterorrhaphy is a very unsatisfactory procedure, because it does not assure permanent permeability of the canal, and it should never be employed as a method of choice. Its adoption may be compulsory in cases where there is a comparatively extensive loss of substance and the two ends can be brought together without undue tension, but where it is impossible to get sufficient overlapping to allow of the two segments being joined side to side. The two cut ends will be freshened obliquely, and the junction will be effected by two rows of interrupted sutures.

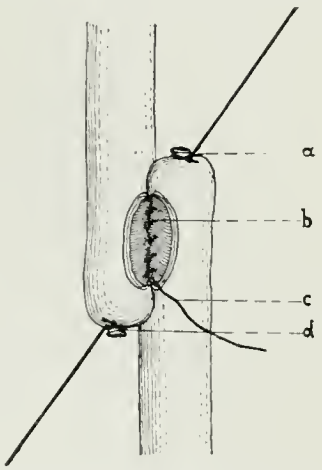

Fig. 338.—Latero-lateral anastomosis of a divided ureter (right side). (*a*) Ligature of the lower end. (*b*) Suture of the posterior edges of the opposed openings. (*c*) End of the thread which has just completed the posterior half of the continuous suture, and is about to begin the anterior portion. (*d*) Ligature of the upper end.

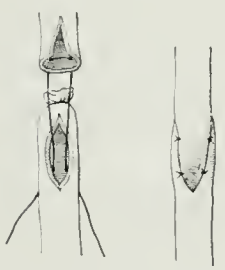

Fig. 339.—Termino-lateral implantation of a divided ureter.

Lateral anastomosis of the two ends, or *termino-lateral implantation*, or *termino-terminal invagination* are the methods of choice.

1. **Lateral Anastomosis.**—The technique is practically the same as in performing entero-anastomosis. The two ends are tied[1] and laid side by side, the lower end to the inner side, overlapping for a length of 3 cms. Then a longitudinal opening 1 cm. long is made in each of the opposed surfaces; the two posterior lips are joined together by a continuous suture of fine catgut, including the whole thickness of the walls; the same thread is then used to unite the two anterior lips (*Fig.* 338). The peri-ureteral tissues are now brought together over the suture-line,[2] and finally the posterior parietal peritoneum is sutured in front of the ureter.[3]

[1] And the two small stumps cauterized.

[2] Monari, "Ueber Ureteranastomosen." *Beiträge zur klin. Chir.*, 1896, t. xv., p. 721.

[3] It may be necessary to drain the retro-peritoneal space. M. Fournier, of Amiens, has obtained a very satisfactory result by lateral anastomosis, the normal permeability of the sutured ureter being demonstrated two months after the operation by segregation of the urines of the two kidneys. (Uretéro-anastomose latéro-latérale suivie de guérison. *Comptes rendus du 19e Congrès franç. de Chir.*, 1906, p. 194.)

2. **Termino-lateral Implantation.**—The lower end is tied with a fine silk thread : $\frac{1}{2}$ cm. below the ligature a longitudinal opening about 1 cm. in length is made ; into this opening the upper end—after having first been incised for a distance of $\frac{1}{2}$ cm.—is invaginated by a double suture passed as in *Fig.* 339. The suture (of fine catgut) carries a needle at either end ; the two needles are passed through the upper end, from within outwards, 3 mms. above the cut edge ; they are then introduced into the lateral opening in the lower end and passed through its posterior wall, again from within outwards. The proximal extremity of the ureter is then drawn into the lateral slit in the distal segment by traction on the ends of the thread, and when sufficiently implanted is secured by knotting the suture.[1]

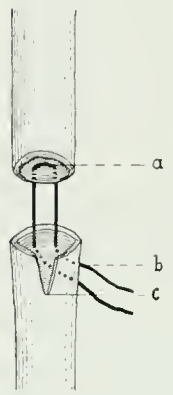

Fig. 340.

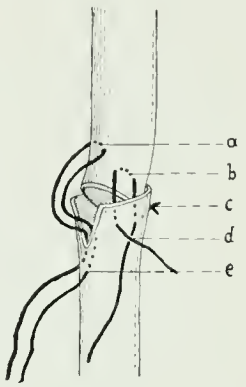

Fig. 341.

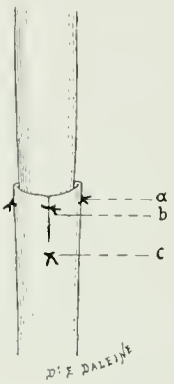

Fig. 342.

Fig. 340.—Termino-terminal invagination of a divided ureter. Invagination of the upper end into the lower split end (Gubaroff). The posterior suture in position. (*a*) Loop of the suture on the inner surface of the upper end. (*b*) Ends of the suture passing through the lower end. (*c*) Slit in the lower end.

Fig. 341.—Termino-terminal invagination (Gubaroff). The posterior suture has been tied. The anterior and one of the lateral sutures have been passed. (*a*) Loop of the anterior suture. (*b*) Loop of lateral suture. (*c*) Posterior suture tied. (*d*) Ends of the lateral suture. (*e*) Ends of the anterior suture.

Fig. 342.—Termino-terminal invagination (Gubaroff). The anastomosis is completed. (*a*) Lateral suture tied. (*b*) Supplementary suture closing the slit in the lower end. (*c*) Anterior suture tied.

3. **Termino-terminal Invagination.**[2]—The inferior end is split longitudinally in front ; a first suture is passed through both segments from within outwards (*Fig.* 340) as above ; then two lateral sutures, then an anterior one (*Fig.* 341) ; the invagination is produced and secured by tightening and then tying these four sutures. A single supplementary suture unites the edges of the small anterior slit (*Fig.* 342).

When dealing with a wound situated low down in the ureter, implantation of the proximal end into the bladder, *uretero-cystostomy*, is the best

[1] Van Hoock. "Experimental union of the ureter after transverse division." *Journal of the American Medical Association*, 1893, No. 9.

[2] Gubaroff. "Ueber ein Verfahren zur Restitution des durchschnitteten Ureters vermittelst direkter Vernähung derselben." *Centralbl. f. Chir.*, 2 Feb., 1901, p. 121.

practice. Here we shall describe Ricard's method[1] which, as it is very simple and does not require the presence of a bougie in the ureter, is well adapted for use in the emergency conditions which we have in view.

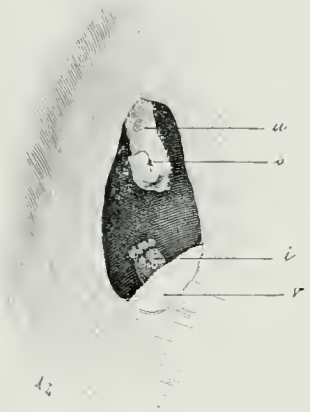

Fig. 343.—Uretero-cystostomy (Ricard's method). Ligature of the lower end; incision and eversion of the upper end. (*u*) Ureter. (*s*) Mucosa of the upper end, everted and fixed by a suture. (*i*) Lower end. (*v*) Area on the bladder wall into which the upper end will be implanted.

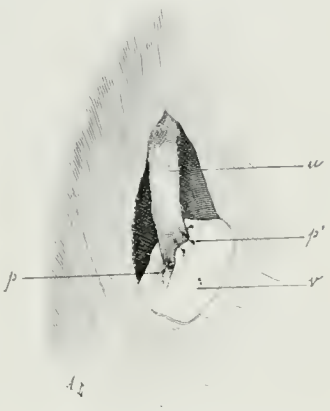

Fig. 344.—Uretero-cystostomy (Ricard's method). Implantation of the ureter into the bladder. (*u*) Ureter. (*v*) Bladder. (*p*) First circle of vesico-ureteral sutures. (*p'*) Second circle of sutures.

The lower end of the ureter is tied and cauterized: the upper end is split longitudinally on its anterior surface and *turned inside out*, and the everted mucous membrane is fixed to the outer wall by one or two interrupted sutures (*Fig.* 343).

Then the point of implantation into the bladder is chosen, making sure that it is easily possible to bring the chosen part of the bladder wall and the ureter in contact without tension: an incision 1½ to 2 cms. long is made in the wall, and the ureter end, prepared in the manner just described, is slipped in through the slit so that it projects freely 1½ or 2 cms. into the vesical cavity; it only now remains to fix it. This is done by passing a circle of four or five interrupted uretero-vesical sutures of No. 0 catgut, picking up the whole thickness of the ureteral and vesical walls with the exception of the mucous lining. About 1 or 1½ cms. outside the first circular row of sutures, a second is introduced, the terminal part of the ureter being thus buried in the wall of the bladder. The next step is to pull up a portion of the bladder wall, situated a little in front of the

Fig. 345.—Uretero-cystostomy (Ricard's method). The ureter is implanted and fixed; the bladder is pulled upwards and secured by a vesico-peritoneal suture to prevent any traction on the ureter.

[1] Ricard. A propos de l'anastomose urétéro-vésicale. *Soc. de Chir.*, 23 juillet, 1907, p. 832. Paul Lelaud. Thèse de doct., Paris, 1907, and *Gaz. des hôpitaux*, 4 février, 1908.

position of the implanted ureter, and to fix it to the pelvic peritoneum by a single suture of thick catgut. The object of this step is to prevent any dragging on the anastomosis.

Again, it may happen that the lesion of the ureter is too extensive to permit of any union between the two ends or any anastomosis between the upper end and the bladder; the only other resource in such conditions is to implant the ureter into the large intestine, into the cæcum on the right side, the sigmoid flexure on the left. It is best to make the implantation into the retro-peritoneal area on the postero-internal aspect of the intestine; the upper end of the ureter being freshened obliquely or slit longitudinally for a length of half a centimetre for the purpose of enlarging the orifice; the muscular coat of the bowel is incised and the mucous membrane seized with dissecting forceps and drawn out through the incision; a small opening is then made in the apex of the cone of mucous membrane, and the margins of this opening are joined to the cut edges of the ureter by a circle of interrupted sutures. By pushing in the end of the ureter, the line of junction is invaginated into the bowel, and the invagination secured by a second circle of non-perforating sutures placed about 1 cm. outside the first.[1]

Traumatic Herniæ of the Kidney.—These are uncommon, and when they occur the organ is not usually completely protruded, but only presents one of its extremities in the wound. If it is uninjured, warm, and not much altered in colour, and *particularly if the pedicle is intact*, reposition after careful cleansing is indicated and is generally very easy. In a case reported by Brandt,[2] the reduction was in the first instance effected by a peasant; but it was not maintained, as renewed efforts of coughing projected the organ outside again, and fortunately so, because it was divided right to the hilum "as if it had been cut with a knife." The pedicle was transfixed and tied, and the kidney excised. The patient made a complete recovery in sixteen days. Nephrectomy is indeed the only appropriate treatment when the organ is seriously damaged, or if it is cold, discoloured, flaccid, and seriously altered.

Lastly, immediate operation is always indicated in cases where the kidney has been wounded by the abdominal route; indeed, under such circumstances the symptoms of intraperitoneal hæmorrhage are usually sufficient indications of the proper course to be pursued. Laparotomy must be performed and the kidney approached through the peritoneal cavity after any associated visceral lesions have been looked for and treated.

[1] Pierre Delbet, *Soc. de chir.*, 24 juin, 1907, p. 731.

[2] *Wiener med. Woch.*, Nov., 1873. See some other cases in Brodeur's thesis: *De l'intervention chirurgicale dans les affections du rein*, 1886.

INJURIES OF THE HYPOGASTRIC REGION.

RUPTURES OF THE BLADDER.

Ruptures of the Bladder.—These may be **intraperitoneal** or **extraperitoneal**, allowing extravasation of urine behind into the peritoneal cavity or in front into the prevesical space ; peritoneal infection or urinary infection of the pelvic cellular tissues is the inevitable consequence of one or other variety.

The ruptures of the peritoneal surface of the organ are the most common, and they are almost certainly fatal[1] if not recognized and properly treated in time.

The symptomatology is by no means always definite enough to exclude the possibility of doubt, and this explains the frequency of late operations performed under the pressure of peritonitic symptoms.

A man in a state of intoxication is knocked down by a vehicle, the wheels of which pass over the lower part of his body ; he loses consciousness, and during the first few hours he presents all the signs of intense abdominal shock : pallor, feeble pulse, coldness of the extremities ; abdomen a little distended and tender on pressure, but without any definite localization of the pain. He passes no urine, notwithstanding repeated and painful attempts. Catheterization, to one's surprise, obtains no urine, or at most only a few ounces heavily charged with blood. After waiting a few hours longer things still remain the same ; no urine is passed naturally, and none can be obtained by the catheter. Further, the usual rounded and tense prominence caused by a distended bladder cannot be felt in the hypogastrium ; often enough, indeed, a resonant note is obtained there, and it is laterally, towards the iliac fossæ, that percussion detects more or less extensive dullness which, like the dullness of ascites, changes its level with alterations in the patient's position. Sometimes even the entire subumbilical region presents an indefinite swelling, which on palpation gives sensations of diffuse infiltration and doubtful fluctuation.

Rupture of the bladder and extravasation of urine into the general peritoneal cavity is now practically certain, and the degree of probability is amply sufficient to justify, and indeed to demand, immediate laparotomy.

The difficulties associated with an early diagnosis are often, however, much more serious.

[1] Ledderhose, however, admits the possibility of recovery without operation in some intraperitoneal ruptures ; in some other cases the peritonitis becomes localized, and the opening of the perivesical abscesses suffices to effect a cure ; he has, for instance, opened a localized intraperitoneal abscess situated in the iliac region on the seventeenth day. At the bottom of the cavity a rupture of the postero-inferior part of the bladder, admitting two fingers, was recognized ; the cavity was drained, and a catheter placed in the bladder. Recovery ensued in three months. ("Zur Behandlung der intra-peritonealen Blasenzerreissung," *Arch. f. klin. Chir.*, 1902, Bd. lxvii., p. 898.) These cases are merely the happy exceptions, nothing more.

Micturition may not be altogether impossible, the patient may still be able to pass a little urine, though certainly in very small quantities without any force; again, and more frequently, it may happen that the catheter, passing undoubtedly through a large tear in the bladder wall, draws off a considerable quantity of urine, and even clear urine. However, in such a case the contrast between the apparent successful catheterization and the undoubted emptiness of the hypogastric region is in itself sufficient to arouse suspicion.

In short, after giving due consideration to the exceptional cases, which are always associated with exceptional lesions, the study of the reported cases leads to the conclusion that in these ruptures the disturbances of the vesical functions are always enough to allow of a sufficiently accurate diagnosis being made without waiting for the appearance of the signs of commencing peritonitis.

In the clinical analysis due consideration must be given to the following points:—

1. **The seat and character of the injury,** which has definitely affected the suprapubic region (a blow with a stick, a kick, a fall flat on the abdomen, the passage of a wheel) and at a time when it was at least probable that the bladder was full.

2. **The absence of voluntary micturition and failure to obtain,** at least in any notable quantity, **any urine by the catheter,** and, on the other hand, the occurrence of repeated and painful attacks of vesical tenesmus. The admixture of blood with the small quantity of urine obtained by catheterization, or even the dribbling of pure blood from the catheter, are evidently only of value in the diagnosis from their association with the signs just mentioned. After a renal contusion the clinical picture is quite different when analysed, notwithstanding an apparent similarity at first sight; the point of impact of the force, the localization of the pain, the results of palpation, prevent as a rule the possibility of any lasting confusion.

3. **The emptiness of the hypogastric region,** the absence of the prominence and dullness normally associated with a distended bladder.

We may add that in these cases, catheterization (which must only be performed with a sterilized instrument and with all aseptic precautions) can scarcely render any other service than that of proving the bladder to be empty. That it may sometimes be possible (particularly when using a metallic instrument) to pass the catheter through the perforation and to feel the end under the abdominal wall, has been proved in several cases, but no reliance can be placed on such a test, and no attempt to apply it should ever be made.

In addition to *traumatic ruptures*, properly so called, some consideration must also be given to the **surgical ruptures** which occasionally occur in the course of an injection into a diseased or contracted bladder, and also to the so-called **spontaneous ruptures.**

Of the first class we need say very little; the surgeon who causes such a rupture usually experiences a very definite sensation of something giving

way; the abrupt disappearance of all resistance to the injection indicates at once the passage of the fluid into the perivesical cellular tissue; sometimes, if the injection is continued, a swelling is seen to appear in the hypogastrium, then to disappear rapidly as diffusion occurs. These ruptures are usually *extraperitoneal*.

With regard to the **spontaneous ruptures**, these are very uncommon, and the pathological varieties are numerous; they express themselves by signs quite similar to those which we have considered above, and they sometimes occur with quite traumatic suddenness—during labour, after violent efforts, etc. The pre-existing pathological state of the bladder[1] and urethra forms an important diagnostic factor.

Many years ago, at a time when the immediate treatment of these grave accidents was still very hesitating, I saw a case of rupture of the bladder from over-distention in a patient suffering from prostatic enlargement. He was brought to hospital with an enormously distended abdomen, which appeared to be filled with ascitic fluid: he had passed no urine for three days; a catheter was passed into the bladder without much difficulty, but no urine came. The catheter was left in the bladder, but during the few hours which elapsed before death occurred not a drop of fluid escaped. At the autopsy about ten pints of urine were found in the peritoneal cavity, and a large perforation was found in the bladder.[2]

It is often difficult to determine in advance if the rupture is intra- or extra-peritoneal, indeed it is not uncommon to find the two conditions combined in such a way as to allow the urine to escape into the peritoneal cavity and at the same time to infiltrate the perivesical cellular tissue; in the reports of operations it is fairly often noted that on making the usual suprapubic incision the space of Retzius was found filled with blood and urine, and when the peritoneum was opened fluid was discovered there also. Practically, as we shall see, it is always advisable to suppose that a rupture is intraperitoneal, and to base the treatment on that supposition until the contrary is proved; besides, the intraperitoneal form is much the commoner of the two varieties.

The seat of an extraperitoneal rupture may be at one or other of two places: **the anterior surface**, or **the base**.

When diffusing itself into the space of Retzius, the fluid slowly distends the lower part of the anterior abdominal wall, forming a rounded swelling which in its form, if not in its consistence, simulates a distended bladder.

[1] Here we may mention the perforations consecutive to ulcerations of the vesical mucosa, to tumours, and to the opening of some perivesical abscesses. (See WAGNER. "Ueber nicht traumatische Perforation der Blase und ihre Folgezustande." *Arch. f. klin. Chir.*, 1892, Bd. xliv., p. 308.)

[2] The same thing occurred in a *stricture* case reported by Michel: The patient had suffered for two years with very pronounced dysuria; during an attack of complete retention, he felt a sudden severe pain in the abdomen, and from that time peritonitic symptoms developed rapidly; he was admitted to hospital three days later in a very alarming condition; an impassable stricture was found, and from the vomiting, the abdominal pain, and the œdema of the hypogastric wall, a diagnosis of rupture of the bladder was made. Hypogastric incision, followed by simple drainage, the patient being moribund. At the autopsy, a perforation the size of a shilling was found on the side of the bladder; it was situated below the line of reflection of the peritoneum, and the serous membrane appeared to have been perforated secondarily. (*Soc. de méd. de Nancy*, 25 jan., 1899.)

However, here again no urine can usually be obtained by catheterization; or if it should happen that any quantity is evacuated, it makes no alteration in the size of the hypogastric swelling, which progressively becomes more prominent, extends and diffuses itself more and more, and before very long the infiltration reaches the perineal pouch.

The symptoms vary in gravity and in rapidity of evolution, according to the extent of the vesical solution of continuity; they are always less urgent than in cases of intraperitoneal extravasation, but none the less they necessitate, as we shall see, intervention on rational lines as soon as the diagnosis is assured.

What is to be done then in the presence of an *intra- or extra-peritoneal rupture of the bladder*?

I.—OPERATION IN THE INTRAPERITONEAL RUPTURES.

If sufficient reasons exist for diagnosing an intraperitoneal rupture, the surgeon's duty is perfectly definite; **the abdomen must be opened, the extravasated urine evacuated, the peritoneal cavity cleansed, and the vesical rupture sought for and closed**; if it should be impossible or inadvisable to close the opening in the bladder wall, it must at least be shut off from the general peritoneal cavity by appropriate measures, and provision be made for draining the bladder cavity. No exception to this rule, or delay in its application, is permissible; any procrastination or hesitation involves very serious responsibility.[1]

Make the incision in the linea alba from the symphysis to two or three inches below the umbilicus, *and at once open the peritoneum*, which is often pushed forward by the underlying fluid, as in an ordinary laparotomy. This is in general much better than to begin by opening the prevesical space after pushing up the peritoneal cul-de-sac, which must in any case be afterwards incised.

In some instances the following method has been adopted: the prevesical space has first been opened, emptied, and cleansed, and, after exploration of the anterior surface of the bladder had failed to show any sign of a rupture, the organ has been incised and its posterior wall examined with the finger *from within*. The first method is, however, preferable, because it permits the chief object of the operation to be attained at once and with less danger of infection.

The peritoneum having been opened, the urine is allowed to escape; the expulsion may be hastened by a little pressure on the umbilical region and on the flanks, care being exercised to prevent extrusion of the intestines. After the fluid has been evacuated as completely as possible, introduce

[1] The mortality, still very high, in the cases of intraperitoneal ruptures submitted to operation is in a large degree attributable to delay, the operation having often been undertaken after the appearance of peritonitis; in forty-five cases, Alexander found twenty-two recoveries and twenty-three deaths (of which fourteen were due to peritonitis). (*The American Association of Genito-urinary Surgeons*, 1901; *Boston Med. and Surg. Journ.*, 1901, No. 5.)

a large aseptic compress under the upper angle of the wound, spread it over the intestines, and place the patient in *a moderately inclined position*, aiding the upward displacement of the intestines with the hand. The inclined position is of very great assistance, and it will always be possible to obtain it by the exercise of a little ingenuity, even though a special table is not available. (See LAPAROTOMY IN CONTUSIONS OF THE ABDOMEN).

Some fluid still remains in the pelvis and iliac fossæ. Sponge this up with gauze swabs, devoting the entire attention in the first place to this step; much less time will be lost in this way than by seeking as soon as the abdomen is opened to find the perforation with the finger alone in the midst of the extravasated urine. Change the protecting compress, which is probably soaked, and then proceed to examine the bottom of the pelvis.

Do not expect to see the bladder projecting prominently, nor to find the rupture lying plainly visible. The empty bladder is flattened out and retracted behind the pubis; if the solution of continuity is large and situated near the apex, it may possibly be discovered at once: but more frequently a search is necessary.

Pass two fingers down to the bottom of Douglas' pouch; draw the posterior flaccid and folded wall of the bladder upwards and forwards; keep the apex well raised, and then inspect the whole extent of the wall thus brought into view.

One may find lesions of varying type: *an almost circular hole;* more often *a slit or fissure* varying in length from $\frac{1}{2}$ in. to 5 in., but usually measuring about 2 in., vertical or oblique in direction, rarely transverse.

Remember that the rupture in the serous coat is always more extensive than in the other layers; separate the edges of the fissure which is first seen, and determine the exact dimensions of the total rupture.

Although it is very exceptional to meet with multiple ruptures, still, after one lesion is discovered, the base and lateral surfaces should be carefully explored by a finger passed through the opening.

The rupture must be closed. The task is comparatively simple when the bladder is opened near the apex or on the upper part of the posterior surface; it is often very difficult when the rupture is situated low down and behind. It will be in the latter case that the full *usefulness of the inclined position* will be appreciated.

First secure the two lips of the tear with two pressure-forceps, or two Kocher forceps if one is anxious to get on quickly; but much better with a double thread passed through each of them not far from the torn margin: *these fixation loops* will be held and kept moderately taut, without undue tension, by an assistant. A fine and well-curved Reverdin needle or an ordinary curved needle may be used for the suturing. How is it to be done?

The essential point in suturing the intraperitoneal portion of the bladder, just as in suturing the intestine, consists in bringing *broad serous surfaces in contact.* There is one difference, however, in suturing the bladder—there is no risk of unduly narrowing the cavity, and one may therefore, with perfect safety, bring very broad surfaces, actual folds, of the wall together.

Two layers of sutures are necessary. They may be either continuous or interrupted. When working at a considerable depth it is often difficult to apply and tighten a continuous suture satisfactorily; under such conditions the interrupted form is the easiest and safest.

The first layer, *the deep layer* (*Figs.* 346 and 347), joins the two lips together, edge to edge; it includes the whole thickness of the walls with the exception of the mucous lining: the needle enters the left lip, a third of an inch from the margin, passes through the serous and muscular coats, and emerges in the cut edge at the outer surface of the mucosa, passes across the gap and picks up on the other side the muscular coat, then the serous

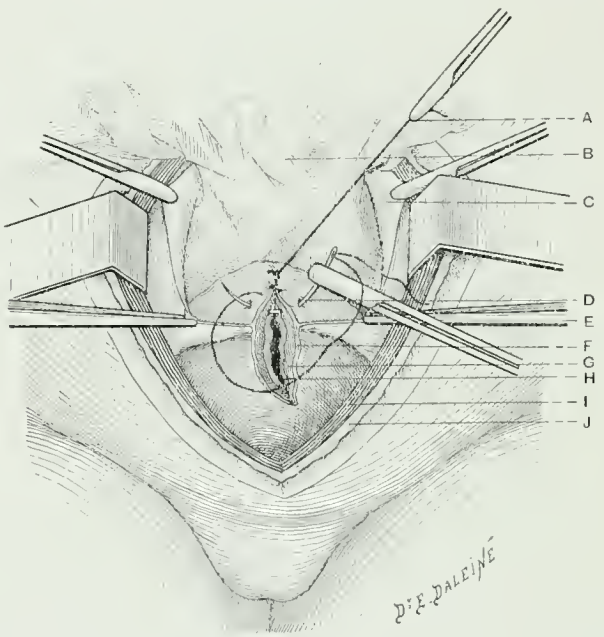

Fig. 346. -Combined intra- and extra-peritoneal rupture of the bladder. First layer of suture; uniting the two lips edge to edge and including the whole thickness of the walls with the exception of the mucous membrane. (A) Initial end of the continuous suture at the extreme posterior part of the wound. (B) Compress protecting the intestines. (C) Parietal peritoneum. (D) Needle traversing the two edges outside the mucosa. (E) Forceps holding the cut margins of the vesico-abdominal peritoneal reflection. (F) Outer coat of the bladder. (G) Muscular coat. (H) Mucous membrane. (I) Rectus muscle. (J) Aponeurosis.

coat, and reappears on the surface at a point symmetrical with the point of entry. If interrupted sutures are employed, they are placed about $\frac{1}{3}$ in. apart.

The second layer—*the superficial layer*, is intended to bury the first by bringing double folds of the bladder wall over it (*Fig.* 348). It is introduced after Lembert's method; in other words, the suture enters the wall from without inwards at a distance of $\frac{1}{2}$ in. from the wound, picks up a fold of the serous and muscular coats about $\frac{1}{4}$ in. broad, crosses the line of the deep suture, and then picks up the wall on the other side in the same extent but in the inverse direction; by thus taking a good grasp of the tissues the

infolding is easier and a firmer suture line is obtained. The extremities of the suture should extend well beyond the rupture into uninjured tissues. When the lesion occupies *the extreme posterior part* of the bladder and encroaches on the base, the more distant end of the wound is always very difficult to close ; the suture should be commenced there, and the greatest care exercised in placing the first points.

If the rupture **is situated at the apex,** or **if it extends on to the anterior surface,** the technique must be modified somewhat, according to the conditions.

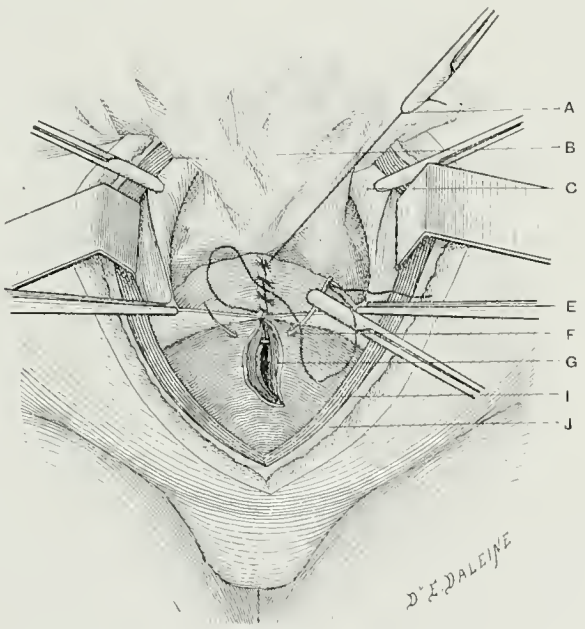

Fig. 347.—Combined intra- and extra-peritoneal rupture of the bladder. Continuation of the first layer of suture on to the extraperitoneal portion. (A) Initial end of the continuous suture at the extreme posterior part of the wound. (B) Compress protecting the intestines. (C) Parietal peritoneum. (E) Forceps holding the cut margins of the vesico-abdominal peritoneal reflection. (F) Needle picking up the external coats of the bladder. (G) Muscular coat. (I) Rectus muscle. (J) Aponeurosis.

1. The rupture is closed first by the deep layer of sutures (*Figs.* 346 and 347) ; then a second layer is introduced, after Lembert's method, from behind forwards (*Fig.* 348), and when the suture reaches the peritoneal reflection *it passes directly from the bladder to the parietal layer* (*Fig.* 340), along which it is continued, so restoring the vesico-abdominal peritoneal fold, and at the same time closing the peritoneal cavity. It only then remains to complete the suturing of the extraperitoneal segment of the wound by introducing the second layer.

When the injury is quite recent, the bladder healthy, and the margins of the vesical wound not lacerated, this method of suture with complete

closure of both bladder and peritoneal cavity is perfectly legitimate: but it is always advisable to drain the prevesical space.

2. When the rupture only extends a short distance on to the peritoneal surface, it is a good plan to *shut it off altogether from the peritoneal cavity* in the following manner: the anterior parietal peritoneum is stripped up over a limited area at the lower end of the parietal wound, and the peritoneal flap thus obtained is stitched to the serous coat of the bladder *behind the line of suture, which in this way becomes entirely extraperitoneal.*[1]

Lastly, in certain cases it is impossible to suture the vesical wound satisfactorily, or from the first the efficacy of suture is doubtful because of

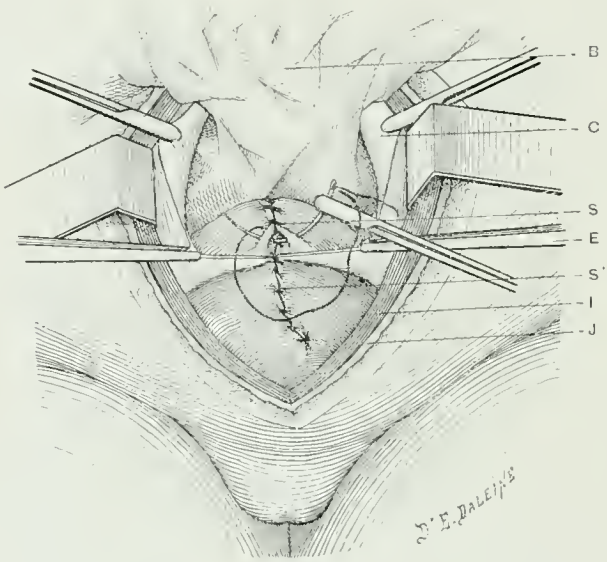

Fig. 348.—Combined intra- and extra-peritoneal rupture of the bladder. Second layer of suture; continuous suture bringing double folds of the wall together over the first suture line. (B) Compress protecting the intestines. (C) Parietal peritoneum. (S) Second continuous suture on the intraperitoneal portion. (E) Forceps holding the cut margins of the vesico-abdominal peritoneal reflection. (S') First layer of suture. (I) Rectus muscle. (J) Aponeurosis.

the damaged state of the wall or because of old inflammatory lesions of the bladder: under such circumstances it would be in the last degree dangerous to close the abdomen completely. Drainage is then absolutely necessary, and if properly carried out can give very good results.

[1] Hellendall has studied and recommends this method of stripping up the parietal peritoneum, and reports a case which was treated by Madelung. M. O. Hildebrandt has also employed the same method in dealing with a median rupture about 4 in. in length which extended from the anterior surface an inch in front of the apex, over the apex, and down the posterior surface almost to the base of the prostate: the parietal peritoneum was sutured to the serous covering of the posterior vesical wall as far down as possible, in such a manner as to place the whole length of the rupture outside the peritoneal cavity. ("Ueber die extra-abdominale Versorgung intra-abdominaler Blasenrisse." *Beitr. zur klin. Chir.*, 1903, Bd. xxxvii., 3, p. 776.)

When dealing with a rupture situated quite posteriorly and extending to the bottom of Douglas' pouch, the lower end of the opening being out of reach; then, after carefully cleansing the peritoneal cavity, introduce a large drainage tube surrounded by layers of gauze right to the bottom of the pouch behind the bladder, and of course leave a catheter in the bladder. Roux has obtained a successful result by this method; for two weeks all the urine escaped by the suprapubic wound, gradually returning afterwards to the natural channel. It is certainly not a method of choice, but under certain circumstances it is nevertheless extremely valuable.

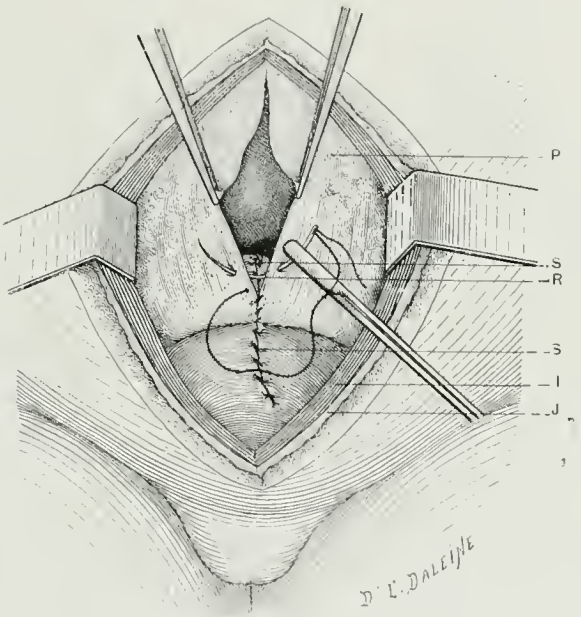

Fig. 349. Combined intra- and extra-peritoneal rupture of the bladder. Continuation of the second layer of suture along the cut margins of the anterior parietal peritoneum, so restoring the vesico-abdominal peritoneal reflection. (P) Anterior parietal peritoneum. (S) Intraperitoneal portion of the wound sutured. (R) Suturing the parietal peritoneum. (S') Extraperitoneal portion of the wound. (I) Rectus muscle. (J) Aponeurosis.

If the rupture is situated near the apex, and suture is impracticable or too precarious, the margins of the vesical opening may be sutured to the skin in the best manner possible, or to the aponeurotic layers in the hypogastric region. The peritoneal cavity will be shut off above and behind the bladder by gauze packing.

Whatever be the method adopted, before closing the abdomen the peritoneal cavity must be carefully cleansed with dry gauze swabs, or, if the accident is not quite recent and some indications of peritoneal irritation are already present, by means of lavage with warm sterile saline solution.

II—OPERATION IN THE EXTRAPERITONEAL RUPTURES.

Operation is generally simpler in cases of extraperitoneal rupture occupying the anterior surface of the bladder. It consists essentially in a hypogastric incision, which in many conditions may be all that is needed. A catheter tied into the bladder meets only a part of the indications; at least, when there is undoubted urinary infiltration of the hypogastric region, there is no other rational treatment than that which is applicable to any infiltration: the opening of the focus and the provision of free drainage for the escaping urine.

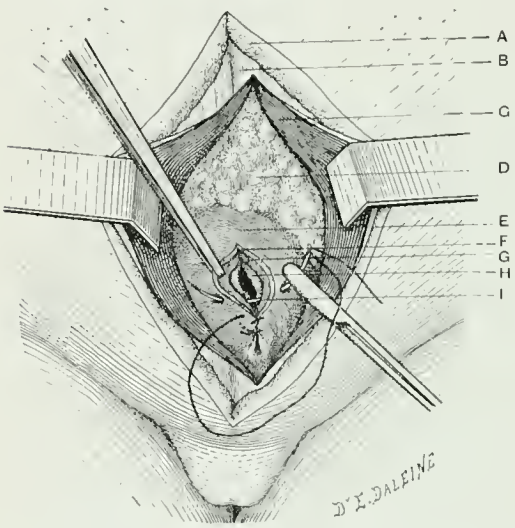

Fig. 350.—Extraperitoneal rupture of the bladder. First layer of suture; continuous suture, including the whole thickness of the walls with the exception of the mucosa. (A) Subcutaneous fatty tissue. (B) Aponeurosis. (C) Rectus muscle. (D) Prevesical fat, pushed up. (E) Apex of the bladder. (F) External fibrous coat of the bladder. (G) Muscular coat. (H) Mucous membrane. (I) Needle traversing the two lips outside the mucosa.

Therefore make a suprapubic incision; do not forget that, owing to the infiltration, all the tissue planes will be considerably thickened; keep strictly to the middle line, which will be sufficiently indicated by the umbilicus and symphysis; go down to the aponeurosis, which, though it may be more or less discoloured with blood, is always perfectly recognizable; divide it, and the underlying prevesical space, filled with blood and urine, will be exposed. Open the space *from below upwards*, and at the upper part of the incision push back the subparietal tissues, first with the finger, then with a retractor; and thus the safety of the peritoneal reflection will be secured. Empty and sponge the prevesical space; usually the rupture will be seen without difficulty.

If the rupture is *comparatively recent and its margins not lacerated*, and —another necessary condition—if it is *not situated too low down* behind the symphysis, or too deep and inaccessible, then suture it.

Here again, the first step consists in exposing the lesion and drawing it well up into the external wound by means of one or more traction threads passed through the lips. The method of closure will be by two layers of sutures as before; the deep suture, including the whole thickness of the walls on either side with the exception of the mucous membrane (*Fig.* 350); the superficial suture, infolding the deep one by bringing together broad folds of the adjoining bladder wall over the suture line (*Fig.* 351). Thus the sutured margins form a crest projecting into the interior of the bladder,

and the broad apposition of the two surfaces excludes any possibility of leakage. It is often advisable to suture only the extremities of the parietal wound and to leave a large drainage tube at the centre.

If the rupture is small, the bladder wall contused and friable, the area septic and its appearance unsatisfactory; if suitable instruments and materials are not available; or if it is essential to get the operation over quickly, then the best plan is simply to drain the bladder. The traction sutures will be passed through the skin on either side and tied, and a few secondary sutures will complete the vesico-cutaneous union.[1]

If the bladder wall cuts under the least traction on the threads, do not persist in trying to carry out the suturing; introduce a large drainage tube through the perforation right to the bottom of the bladder, and pack some gauze lightly into the hypogastric space around the tube. Fix the drainage tube to the edges of the skin by a couple of sutures, and to its outer extremity attach a long piece of rubber tubing, which will be led into a receiver placed under the bed, and will act as a syphon. Later on we shall again refer to this syphon drainage, and to the services which may be expected from its use.

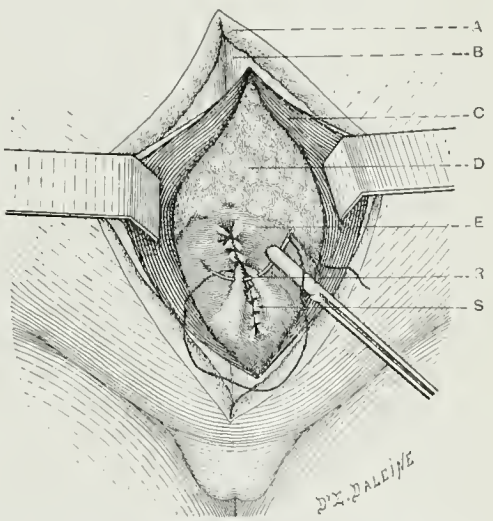

Fig. 351.—Extraperitoneal rupture of the bladder. Second layer of suture; continuous suture infolding the first suture line. (A) Subcutaneous fatty tissue. (B) Aponeurosis. (C) Rectus muscle. (D) Prevesical fat. (E) Apex of the bladder. (R) Superficial suture. (S) Deep suture.

The situation is always more difficult when there is a rupture situated in the neighbourhood of the neck of the bladder and deep-seated infiltration of urine into the posterior part of the perineum at the sides of the rectum, the condition which occurs particularly in vesical lesions associated with fractures of the pelvis.

The treatment of choice under such circumstances is to tie a catheter into the bladder and make a free incision into the infiltrated perineum: but this is not always practicable, for it commonly happens after fractures

[1] In short, suprapubic cystostomy will be performed. This was the method adopted by Prof. Le Dentu in dealing with a long extraperitoneal rupture which extended from the apex of the bladder along the anterior surface almost up to the neck. The wall was too much infiltrated and damaged to allow of suture. Treatment was of necessity limited to uniting the margins of the rupture to the edges of the parietal wound by a few points of suture on either side. Recovery was slow. (R. Petit, "Large rupture extra-péritonéale de la vessie. Guérison," *Ann. des mal. des org. gén.-urin.*, 1897, No. 6.)

of the pelvis that catheterization is impossible. In such conditions perineal urethrostomy has been proposed and sometimes performed; owing, however, to the infiltrated state of the perineal tissues, the operation is not free from serious difficulties. In my opinion it is much better to employ hypogastric drainage by means of a suprapubic cystostomy, making sure of the complete diversion of the urine by syphonage, and of course providing free vent for the extravasated urine by adequate perineal incisions. (See later, URGENT CYSTOSTOMY).

Wounds of the Bladder.—These injuries may be advantageously considered in two groups: (1) *Accidental wounds* in the ordinary sense of the term; (2) *Surgical wounds* inflicted during an operation.

1. **Accidental wounds** are most often caused by blunt instruments: stakes, spikes, pitchforks, rods of any kind, and the bladder may be reached by two routes, *by the anterior abdominal wall* or *by the perineo-cruro-genital region*—in other words, by way of the rectum, the vagina, the perineum, or the obturator foramen. **Gunshot wounds**, which are not uncommon and are always very serious, have multiple ways of entry: they usually perforate the organ completely, and practically must always be considered to be intraperitoneal. The other varieties of wounds can only affect the bladder in the ante- or sub-peritoneal regions—that is, at the anterior surface or at the trigone; but they may also *traverse the organ completely, and so involve the peritoneum secondarily*, as in an interesting case reported by Delagenière.[1]

The patient was a carpenter who, in falling from a scaffold, had been impaled by a spike, which had penetrated the perineum. On the left side there was a wound about 2 inches in length directed from the tuberosity of the ischium towards the root of the scrotum. When explored with the finger the wound was found to be very deep, and a considerable accumulation of clot could be felt. A gum-elastic catheter, gently introduced into the wound, passed in to its full extent. Some urine mixed with blood was obtained by catheterization; the abdomen was tender to pressure in the middle line above the pubis.

The perineal wound was first of all explored with the finger, and it was found that the urethra was not ruptured, but that the surrounding tissues were stripped from it. The cavity was temporarily packed with gauze.

The abdomen was then opened from the pubis to the umbilicus, the patient being in the inclined position; the peritoneal cavity contained a quantity of darkish fluid, a mixture of blood and urine, and the intestinal loops were reddened and inflamed; the bladder was distended with clots, which gave it a slaty colouration, and on its posterior wall there was a transverse perforation about $\frac{3}{4}$ in. long from which dark fluid similar to that found in the peritoneum was escaping. The edges of the vesical wound were secured with forceps and then brought together with a continuous

[1] H. DELAGENIÈRE. "Plaie avec double perforation de la vessie par instrument contondant. Laparotomie et cystostomie sus-pubienne: Guérison." *Arch. prov. de chir.*, avril. 1898, p. 240.

suture of catgut for the mucosa and a second continuous sero-serous suture. The peritoneal cavity was washed out with sterile warm water, a drainage tube being placed in the pelvis behind the bladder, and the peritoneum closed except at the point where the tube emerged. The anterior surface of the bladder was then exposed at the lower part of the parietal wound ; it was secured with two pairs of forceps and incised, the clots were evacuated, and at the left side of the trigone a perforation large enough to admit two fingers was discovered, and in which the gauze introduced by the perineal wound could be seen. After an unsuccessful attempt at suturing the perforation, the perineal wound was again packed with gauze, and the suprapubic opening in the bladder was sutured around a syphon drainage tube. The patient recovered.

We entirely approve of the treatment adopted by Delagenière in this case, and the prognosis of these wounds of the bladder, formerly almost hopeless, cannot but be greatly improved by early and complete operation.

Therefore, if the wound is situated on the anterior abdominal wall, one will be well advised to make a suprapubic median incision as soon as possible and, if there is any suspicion of an intraperitoneal lesion, to open the peritoneum in its lower part at once. A comparatively small opening will suffice at first ; and if any blood and urine are found in the abdomen the diagnosis becomes certain, and the opening will then be enlarged sufficiently to allow whatever is necessary to be done. Should nothing be found in the peritoneal cavity, the peritoneal incision will be immediately closed and attention directed to the anterior extraperitoneal surface of the bladder.

The necessary treatment will then be carried out on the lines already laid down ; if the margins of the wound are contused and lacerated, and ill adapted for suture, they will simply be attached to the skin edges by a few points of suture, and ample provision made for drainage. When no perforation can be discovered on the anterior surface, but the bladder is dark-coloured, resistant, and apparently full of clot, it should be opened vertically for a sufficient length to allow of its being emptied and cleansed, and the operation will be terminated by attaching the margins of the opening to the skin.

In cases where the wound of entry occupies the lower zone, being situated in the perineum or the rectum, etc., first enlarge it sufficiently to cleanse it and to determine its direction and depth, and also, if urinary infiltration has already occurred, for the purpose of providing adequate drainage. Do not expect, however, to be able to treat the bladder lesion by this route ; all that can be accomplished is to pack the wound temporarily and then proceed to expose the damaged organ by suprapubic incision, and deal with it in the manner described above.

2. **Surgical wounds of the bladder** belong to different varieties : they may be inflicted during the performance of laparotomies, operations for hernia, or operations on the rectum, vagina, or uterus. We shall refer again to these accidents when speaking of strangulated hernia, etc. When the bladder is opened during the course of a laparotomy, the treatment

necessary is quite evident, and much more easily executed than in the case of the deep-seated and inaccessible lacerations which are sometimes produced at the bottom of the vagina or in a hernial region: the opening must be closed at once by careful suture in the manner already described, and when the operation is finished, the abdomen can be closed completely if there are no other contraindications, and a catheter should be tied into the bladder. The unintentional wounding of the bladder usually occurs in making the abdominal incision,[1] and as soon as the accident is recognized the first care should be to shut off the rest of the abdominal cavity with gauze compresses, and the operation must not be continued until the vesical wound has been properly closed.

RUPTURES AND WOUNDS OF THE UTERUS.

Traumatic lesions of the unimpregnated uterus[2] are very uncommon (I am speaking of injuries inflicted by the abdominal route), and are associated with no special indications; if during the course of a laparotomy performed for a penetrating abdominal wound, the uterus is found to be injured, the lesion will be repaired by suture (*Fig.* 352) which is also the best means of effecting hæmostasis.

Fig. 352.—Suture of a wound in the uterus. The deep sutures picking up the whole thickness of the wall with the exception of the mucous membrane; intermediate superficial sutures.

That which follows applies to **ruptures and wounds of the gravid uterus**—and one may add, beyond the third month of pregnancy. At an earlier stage the organ still lies altogether in the pelvis, and is but little exposed to risk of injury by the abdominal route.

[1] This is an accident against which precautions should always be taken by making the first opening in the peritoneum only at the middle of the sub-umbilical incision and through a fold which allows itself to be easily lifted up by the forceps (see *Figs.* 246 and 247). In cases of large tumours or large fluid accumulations occupying the pelvis and lower abdomen, the bladder, in addition to being pushed forward, is also often pushed upwards *en masse*, and is therefore exposed to considerable risk of injury. In such cases a layer of tissue will be found which cannot be picked up in a fold nor raised from the underlying structures, and if the incision is continued it will penetrate into a dense reddish tissue from which there will be considerable oozing; stop at once, and look for the peritoneum higher up at the upper angle of the incision.

[2] See the article, URGENT UTERINE CURETTAGE, for perforations of the uterus.

I.—RUPTURES AND WOUNDS OF THE GRAVID UTERUS (APART FROM LABOUR).

The *ruptures* resulting from an injury to the abdomen, such as a blow or a kick, etc., are produced by a bursting action, and the uterine wall gives way first on its serous surface. They are usually situated on the anterior wall, and may be either incomplete, involving only the serous and a variable thickness of the muscular coat, or complete and penetrating. They are also generally combined with a series of secondary fissures radiating more or less widely from the borders of the principal lesion.

Hæmorrhage is the chief accident associated with these ruptures; it may be rapidly fatal, and constitutes the immediate indication for laparotomy. The blood and clots will be carefully evacuated, and the laceration, whether complete or incomplete, closed by suture, which will at the same time, as already stated, check the bleeding, and may perhaps allow the pregnancy to pursue its normal course. It is only when the lesions are very extensive and irreparable that it becomes necessary to empty the womb, after sufficiently enlarging the wound, and to perform hysterectomy, total or supravaginal.

With regard to the *wounds* of the uterus, our knowledge historically is comparatively complete, thanks to the paper by MM. Estor and Puech[1] based on forty cases, but the " urgent " surgical treatment is still somewhat uncertain owing to the small number of detailed observations from which practical conclusions can be drawn.

As illustrations, let us take first the summaries of two very interesting cases treated by Schwartz and Albarran.

A young woman, 22 years of age, between six and seven months pregnant, received a knife-stab in the abdomen, to the left of the middle line, which produced an oblique wound extending from below upwards and from left to right nearly to the umbilicus, and from the wound a loop of small intestine about 36 inches in length, and both feet of the fœtus, protruded. Operation was performed seven hours after the occurrence. The protruding intestine was cleansed, the abdominal wound enlarged, and it was then discovered that the uterus had been opened by a transverse wound which stretched across the anterior surface just below the fundus from one cornu to the other; through this the whole of the fœtus except the head had escaped. The abdomen was full of clots. The uterine wound was enlarged with scissors after pressure-forceps had been applied to the large bleeding vessels, and then the fœtal head and placenta were extracted. The peritoneum and uterine cavity were washed with warm boiled water, and the uterine wound was closed with twelve sutures of No. 4 catgut. The

[1] Estor and Puech, " Des plaies pénétrantes de l'utérus gravide." *Revue de gynécologie et de chirurgie abdominale*, 10 déc., 1899, No. 6, p. 963. See also P. Rebreyend, *Les plaies perforantes de l'utérus*. Thèse doct. de Paris, 1901.

intestine was replaced, and, after drying the peritoneal cavity, the external wound was sutured.

The patient died four and a half days after the operation.[1]

Albarran's patient was a young woman, about four and a half months pregnant, who had fired a revolver bullet (calibre 8) into her umbilical region. She was in a state of semi-coma, her extremities were cold, the temperature was 97·6,° and the abdomen slightly distended. Laparotomy was performed five hours after the accident. The abdomen contained a large quantity (about four pints) of mixed blood and amniotic fluid. Five wounds were found in the small intestine, four being situated in the upper third of the ileum and the fifth in the jejunum about 16 inches below the duodeno-jejunal flexure; the last was sutured, and the intestinal segment, 8 inches long, containing the others, was resected and the continuity of the gut restored by circular enterorrhaphy. On the fundus of the uterus there was *a wound through which a long loop of the umbilical cord protruded*, and very low down, on the posterior wall, a second hole, the wound of exit of the bullet, was found.

"After having tied it with silk," writes Albarran, "I resected the prolapsed portion of the umbilical cord, pushed the stump back into the interior of the uterus, and then sutured with silk the two openings which the bullet had made." The abdomen was cleansed and the abdominal wall sutured, a gauze drain being left in the pouch of Douglas. The fœtus was expelled next day and the patient recovered.[2]

The gravity of the symptoms in these two cases commanded immediate intervention. Even when the situation is less urgent, the general indications which we shall lay down under the following heading (see also WOUNDS OF THE ABDOMEN) are still equally applicable, and immediate laparotomy will be the wisest course to take.

When the abdomen is opened one may be faced by lesions of very varying characters, complicated or not by extrusion, partial or complete, of the fœtus, placenta, and membranes, and rapid decision as to the correct line of action will often be difficult.

We will consider first the simplest possible condition: **the wound is incomplete**, the uterine wall being involved to a variable depth, but *the cavity is not opened* and the fœtal membranes are not affected.

Simple closure of the wound by interrupted sutures is the only treatment indicated in such circumstances, and the suture is also the best means for arresting the bleeding; either silk or catgut may be used, and the sutures should enter at about half an inch from the margin, and include the whole thickness of the muscular wall of the uterus. (See *Fig.* 352).

But in another case the wound is **penetrating**; the amniotic fluid

[1] *Bull. de la Soc. de chir.*, 1887, t. xiii., p. 628.

[2] *Ibid* 1895, p. 243.

has escaped and the fœtus is dead, but *there is no protrusion* : the fœtus and the membranes are entirely retained within the uterine cavity.

Here again—at least if the lesions of the uterine wall are not very extensive—it will be well to confine the operation simply to the careful closing of the wound. Abortion—which is not usually long delayed—is a simpler and safer means of emptying the uterus than Cæsarean section.

The situation is different when **part of the fœtus or the membranes are protruding through the wound.** Should the protrusion be reduced and the wound sutured over it, the fœtus being left to be expelled spontaneously ? Or should the wound be at once enlarged and the uterus emptied ?

We have seen that Albarran contented himself with tying the prolapsed loop of the cord, replacing the stump in the uterus, and suturing the uterine wound : his patient delivered herself naturally of a four-months' fœtus, and recovered. This, therefore, seems the appropriate treatment of a case where only a small portion of the fœtal appendages is protruded.

If, however, a fœtal limb is found prolapsed through the wall of the uterus, particularly when pregnancy is well advanced, it may neither be easy to reduce nor to retain after reduction. Further, it is difficult to suture a large distended uterus satisfactorily, and even if apparently satisfactory there would be good reason to fear that the sutured wound might be burst open again by the expulsive efforts.

However that may be, reduction of the small protrusion and suture of the uterine wound ought to be the first choice, and no more extensive operation should be undertaken unless evidently necessary.

When there is a more considerable prolapse of the fœtus and fœtal appendages, if all the uterine contents are found in the peritoneal cavity, the line of treatment is of course quite definite.

Complete the extraction of the fœtus, after enlarging the uterine wound if necessary ; then remove the placenta, which usually presents itself in the wound as soon as the uterus begins to contract ; should it not come away readily, separate the adherent part gently with the fingers, and make sure that none of the membranes are left behind. If the uterine wall is not too much damaged, if the tear is single and its borders fairly regular, in short, if repair seems possible and likely to be fairly easy, then proceed to close the opening by a series of interrupted sutures, carefully introduced, to obtain the best possible adjustment of the edges, taking a good hold of the muscular wall of the organ, but without perforating the mucous membrane.

When the conditions are unfavourable for conservative measures, when there is dangerous hæmorrhage, and when the uterus is perforated at several points, burst, or extensively fissured, then removal is necessary, and either supravaginal or total hysterectomy will be performed (see *Fig.* 353 *et seq.* and *Plate VII*). Hysterectomy will in many cases be the best treatment.

II.—RUPTURES OF THE UTERUS DURING LABOUR.[1]

We cannot here go into the obstetrical question, etiology, etc.; it is to be noted that the signs of rupture are far from being uniform or always striking: the accident is sometimes indicated by a profuse external hæmorrhage, cessation of uterine contractions, rapid alteration of facies, rapid and feeble pulse; at other times there is no hæmorrhage by the vagina, the child and placenta are delivered naturally, and the serious uterine lesion is only indicated by the symptoms of internal hæmorrhage or of commencing peritonitis.

Uterine ruptures cause death in two ways: *by hæmorrhage* and *by infection*, and of the two hæmorrhage is much the more common.

It is not, however, the immediate hæmorrhage that is generally fatal; the patients usually survive for several hours, and can sometimes even endure long and troublesome journeys, and they ultimately succumb to a second bleeding which is sometimes provoked by the delivery, spontaneous or artificial, of the child.

Stress must be laid on these facts because they show: (1) That in the great majority of cases there is time for operative measures: and (2) That it is advisable to refrain from any obstetrical manœuvre destined to terminate the confinement until everything is ready for the immediate performance of laparotomy.

The ruptures may be *complete or incomplete*. When complete they involve the whole thickness of the uterine wall over a variable extent, often extending into the cervix, the vagina, the broad ligament, or the bladder; they are intraperitoneal, and blood consequently escapes into the abdominal cavity, while the child is also more or less completely expelled through the wound.

The incomplete ruptures affect only the mucous and muscular coats: the peritoneal covering remains intact, but is stripped up and forms an adventitious pouch which has often been taken for the uterine cavity in digital examinations of the interior of the organ, and in which the fœtus or part of the fœtus may be incarcerated; in cases of lateral rupture the blood escapes into the broad ligament and produces enormous hæmatomata, stripping up the peritoneum very widely.

Theoretically it appears that, though the danger of hæmorrhage may be quite as great as in a complete rupture, there should be little danger of peritoneal infection in the case of an incomplete rupture; practically, however, it is impossible to count on this relative benignity, for two reasons:

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[1] Traumatic ruptures during labour caused by external violence may occasionally be seen; as in a case recorded by M. Maygrier, in which a woman when in labour received a kick in the abdomen; she was brought to hospital in a very serious condition; the uterine contractions had ceased, and the child was dead. Nothing could be recognized by abdominal palpation but a vast area crepitating from effused blood. Before anything could be done the patient died. At the autopsy, a large clot weighing about 23 ounces was found lying in front of the uterus, and much liquid blood in the pelvis and iliac fossæ; on the anterior surface of the uterus, above Bandl's ring, there was a large and deep laceration, which did not, however, penetrate into the uterine cavity, and from which numerous smaller tears radiated. (*Soc. obstétricale de France*, 23 avril, 1892.)

(1) The peritoneal pouch is sometimes perforated at a distant point and no real barrier to the entrance of infection exists;[1] and (2) The diagnosis of the variety of rupture is as a rule extremely difficult, and one may often be deceived even after a careful manual examination of the interior of the uterus.

The natural conclusion is this: when there are sufficient reasons for diagnosing the existence of a rupture of the uterus, *laparotomy ought to be performed as soon as possible.* At the present day any manœuvres executed by means of the genital passages must be considered to be both untrustworthy and dangerous; in a case where transporting the patient is

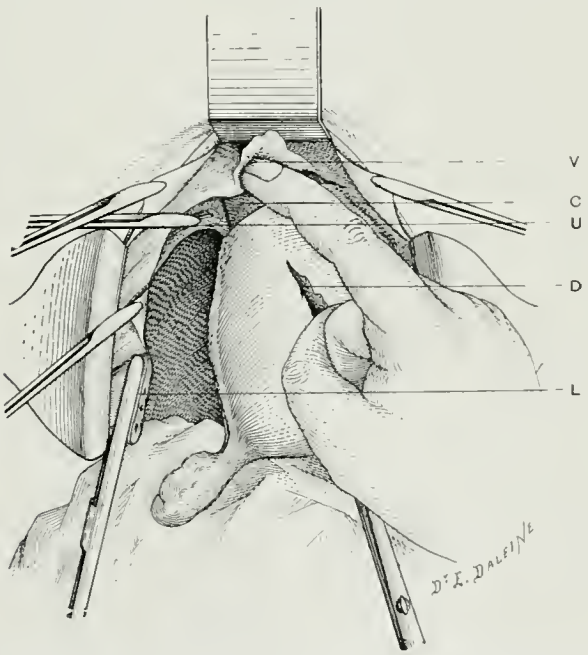


Fig. 353.—Total abdominal hysterectomy. The left broad ligament clamped and divided; separating the vesico-uterine peritoneum. (V) The finger separating the anterior peritoneum. (C) Vaginal wall. (U) Forceps holding the left uterine artery. (D) Uterine laceration. (L) Clamp holding the upper border of the left broad ligament.

unavoidable, gauze packing may, however, be employed as a temporary measure.[2]

At the Hospital Beaujon I have had occasion to perform a laparotomy of this kind, at a very late stage and under almost hopeless conditions. I remember it as a striking operation, demanding a good deal of sangfroid but presenting no particular technical difficulties.

[1] Varnier. "Du traitement des ruptures de l'utérus." *Rapport au Congrès d'obstétrique, de gynécologie et de pédiatrie.* Nantes, 1901, and *Annales de gynécologie et d'obstétrique.* 1901, p. 249.

[2] Or also in ruptures of limited extent, situated very low down and incomplete: all of which conditions are very difficult to diagnose with certainty.

Make a large incision in the middle line below the umbilicus with the patient in the horizontal position, or at the most only very slightly inclined ; be prepared to see a large rush of blood as soon as the abdomen is opened ; sponge this up quickly with large gauze compresses : then, after displacing the intestines upward and covering them with a compress, put the patient in the inclined position. The uterus is now in view, and through the gaping wound the dead child is protruding. The next step is to empty the uterus ; this is usually a very simple matter : sometimes indeed the child and placenta may have already escaped into the peritoneal cavity.

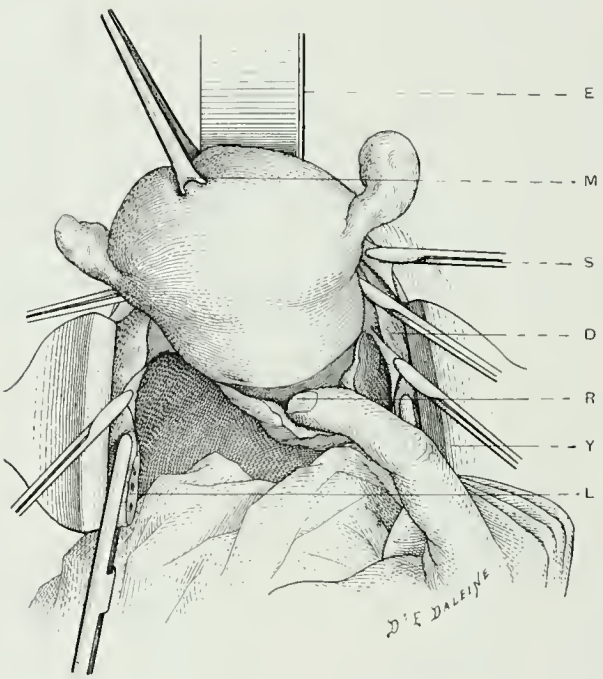
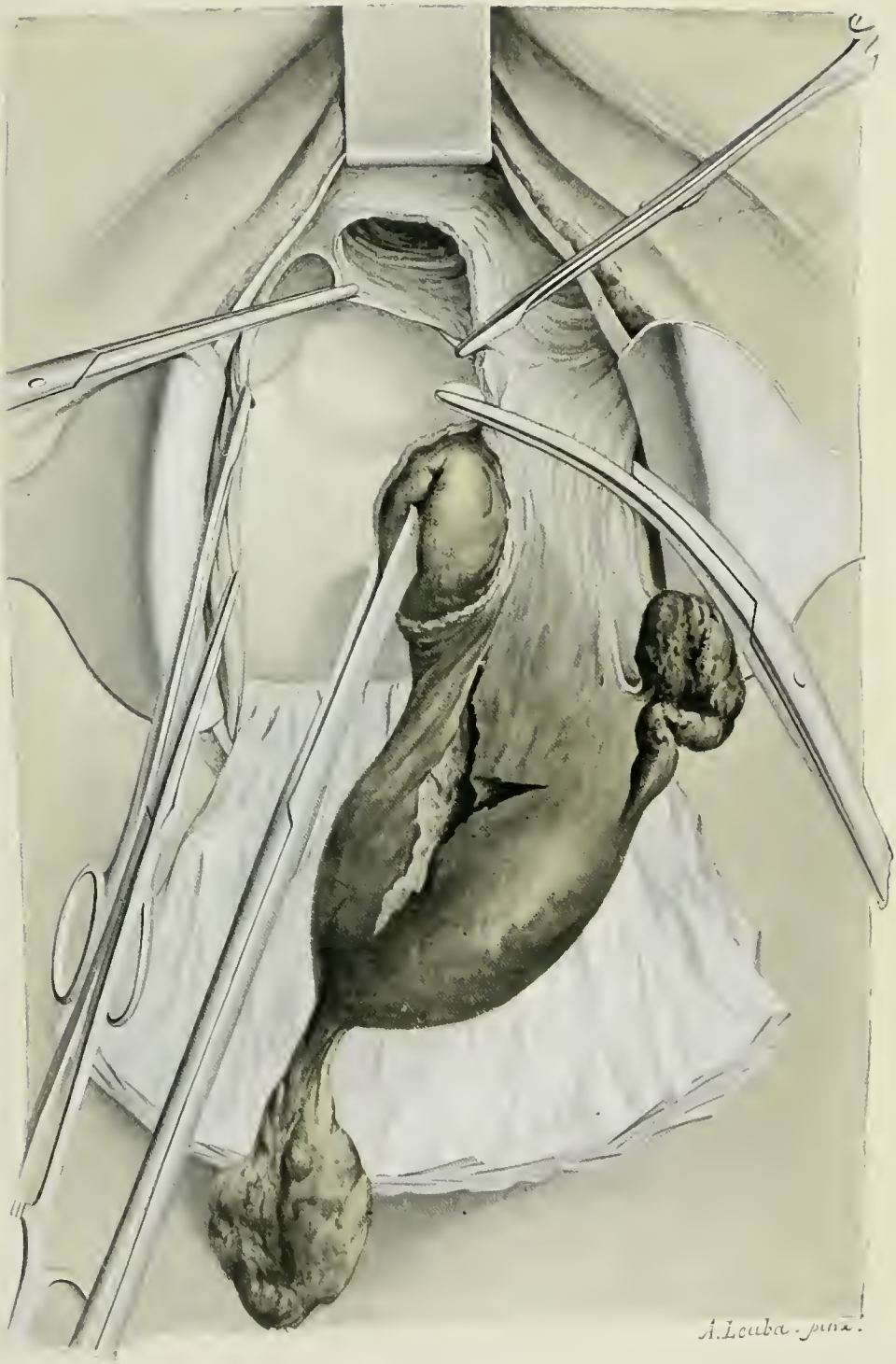


Fig. 354.—Total abdominal hysterectomy. Separating the posterior peritoneum. (E) Retractor placed in the lower angle of the abdominal wound. (M) Uterus pulled upwards by vulsellum forceps. (S) Forceps securing the parietal peritoneum. (D) Abdominal wall. (R) Finger separating the posterior peritoneum. (Y) Lateral retractor. (L) Clamp on the upper border of the left broad ligament.

Now proceed at once to the broad ligaments ; clamp the upper two-thirds of the left ligament and cut it ; below, along the uterine border, strip up the loose cellular tissue with the finger and expose the large mass of uterine vessels ; seize the vessels with forceps close to the neck of the uterus and cut them; push them aside with the finger, and go down a little further, always keeping in close contact with the cervix, to the vaginal attachment. In front, in the utero-vesical space, incise the peritoneum with a cut of the

Plate VII.—Total abdominal hysterectomy. The right broad ligament is divided, both uterine arteries are secured with forceps, the cervix is freed and pulled upwards, the uterus is tilted to the left, a clamp is being applied to the left broad ligament.



TOTAL ABDOMINAL HYSTERECTOMY

knife from left to right; do the same posteriorly; in front, separate the bladder with the tip of the index finger, keeping close to the uterine

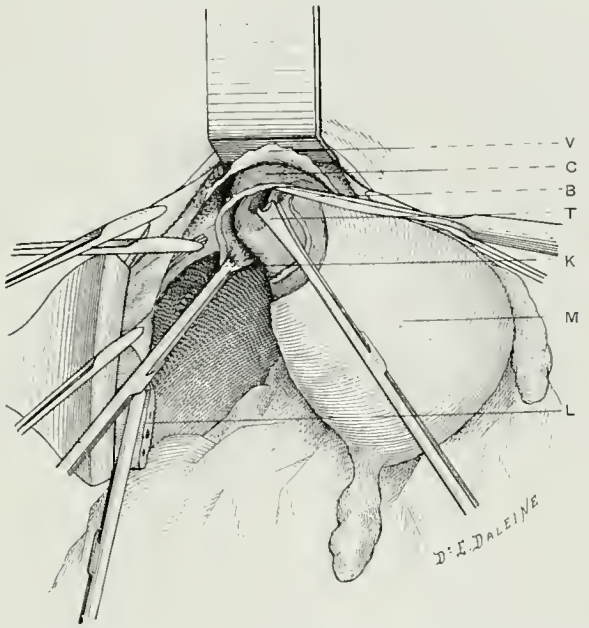


Fig. 355.—Total abdominal hysterectomy. Dividing the vagina; tilting the cervix upwards. (V) Vesico-uterine peritoneum, retracted. (C) Vaginal wall. (B) Dividing the vagina from left to right. (T) Cervix seized and pulled upwards with vulsellum forceps. (K) Lower edge of the divided vagina, secured with forceps. (M) Uterus. (L) Clamp on the upper border of the left broad ligament.

surface (*Fig.* 353); strip up the recto-uterine peritoneal fold behind (*Fig.* 354).

Now open the vagina in the anterior part of the left lateral fornix, prolong the incision in front and behind the cervix, from left to right, at the same time tilting the uterus to the right; seize the cervix, or what represents it, firmly with strong vulsellum forceps, and by pulling on it accentuate the tilting (*Fig.* 355) of the uterus until the right border of the organ comes into sight; then clamp and cut the right uterine vessels in the base of the right broad ligament, and close to the uterus. It only now remains to clamp and divide the upper part of the right broad ligament, and the organ is free (*Plate VII*).

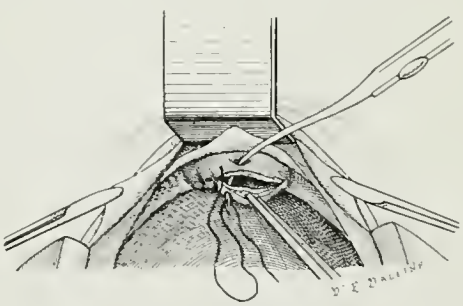


Fig. 356.—Total abdominal hysterectomy. Closure of the vaginal vault.

Some bleeding will probably still persist if the laceration has extended

to the broad ligaments or to the neighbouring organs; but there is now plenty of room in which to examine the wound properly, to apply forceps to any bleeding points, and to undertake any necessary reparative measures. Ligatures must now be substituted for the forceps which are controlling the vessels in the broad ligaments: the ligatures must be firmly but carefully tied, because the tissues cut very readily.

The terminal steps of the operation are important. If the uterine laceration was incomplete, or if complete it was quite recent, and there had been no interference with it from below before the operation, then the

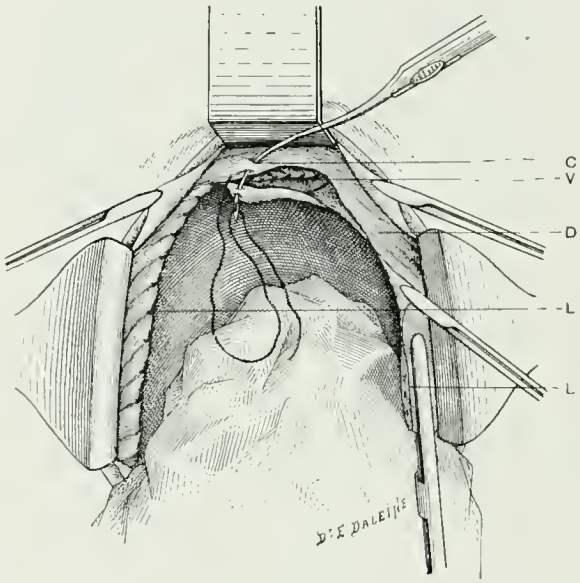


Fig. 357.—Total abdominal hysterectomy. Suturing the pelvic peritoneum. (C) Suturing the peritoneum over the vaginal vault. (V) Sutured vaginal vault. (D) The cut right broad ligament. (L) Left broad ligament sutured. (L') Clamp on the upper border of the right broad ligament.

vaginal vault may be closed (*Fig.* 356) and the peritoneal flaps carefully sutured over it (*Fig.* 357).

Such favourable conditions seldom obtain, however, and vaginal drainage by a strip of aseptic gauze is usually advisable.

That is *total abdominal hysterectomy* for rupture of the uterus.[1] *Supravaginal hysterectomy* may be performed instead if it appears simpler and more rapid; the steps of the operation are the same, except that, instead of going down to and opening the vagina, the cervix is divided immediately above the vaginal attachment; the section of the cervix is made from

[1] M. Loussot has published a very interesting case of total abdominal hysterectomy performed in the country in a farmhouse, and followed by recovery. (*Gazette des hôpitaux*, 1898, p. 1067.)

left to right while the uterus is tilted strongly to the right.[1] Uterine suture is only applicable in cases where the ruptures are of limited extent, with regular, unlacerated margins and quite recent, and when perfect hæmostasis and adjustment can be obtained.

Any lacerations of the bladder, vagina, or broad ligaments must of course be dealt with as the conditions demand.

SERIOUS HÆMORRHAGE FROM ULCERS OF THE STOMACH AND DUODENUM.

Gastric and duodenal ulcers may be complicated by two serious conditions which demand immediate operative treatment: **profuse hæmorrhage** and **perforation**. Perforations will be considered subsequently in the chapter on peritonitis. Here we shall only discuss those hæmorrhages which by their abundance—particularly when recurrent—cause imminent danger of death.[2]

A stout, vigorous man, forty-four years of age, had suffered some years previously with hæmatemesis, which had ceased under careful medical treatment. His health had become satisfactory except for some pains and indefinite digestive troubles. After feeling unwell for some days, he suddenly felt sick and vomited a wash-hand basinful of red blood, and he is found shortly afterwards with pallid, anxious face, cold extremities, and a wretched pulse. Under treatment he revives a little, and the skin becomes warmer: then in a few hours there is another hæmorrhage as great as the first, soon followed by a black, tarry motion; the epigastric region is rigid and painful; the collapse is so great, and remains so threatening, notwithstanding repeated injections of saline solution, that it appears as if the slightest renewal of the bleeding must be fatal.

What is to be done? Those who have had to treat such cases will remember with what anxiety they put this question to themselves.

A much too favourable opinion had been conceived with regard to the possibilities of surgical treatment in these conditions on the strength of a few brilliant successes, from which far too general conclusions had been drawn; further experience has abundantly demonstrated, not only that immediate laparotomy ought not to be the rule, but rather that it is only indicated under very exceptional circumstances.

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[1] In a case where the rupture was situated low down and in front, and complicated by extensive peritoneal separation, Hartmann, after having performed supravaginal hysterectomy, made the stump extraperitoneal by suturing the edges of the parietal peritoneum together behind it. (*Annales de gynéc. et d'obst.*, 1901, t. lvi., p. 280.) Porro's amputation of the uterus, with fixation of the stump in the parietal wound, should never be performed unless nothing else can be done.

[2] We need say nothing regarding those fulminating hæmorrhages which prove fatal in a few minutes or hours, and in which no therapeutic measures are of any value. The clinical situation is, on the other hand, quite different here from that resulting from repeated small hæmorrhages, although they also may in the end require surgical treatment because of the intense anæmia they produce; this usually takes the form of gastro-enterostomy, which has given excellent results in such conditions.

There cannot be the slightest doubt that a very large number of these apparently almost hopeless cases terminate in unexpected recovery. This point has been proved by Leube,[1] Mickulicz,[2] Hayem,[3] and many others. We have ourselves seen three cases during the past few years; in the first two we were called to attempt operation if it was still possible; but the general condition compelled us to conclude that the least degree of anæsthesia or the simplest surgical interference must be fatal. However, these three patients, contrary to all expectation, very slowly recovered, and there was no recurrence of the hæmatemesis. Absolute rest in bed, nothing whatever by the mouth,[4] enemata of warm water, ice to the epigastrium, and subcutaneous infusion of saline solution constitute the main elements in a line of treatment which is not without some real value. In short, we must try to establish the conditions most favourable for spontaneous hæmostasis, which is, however, almost entirely dependent on the calibre of the eroded vessel, the anatomical characters of the ulcer, and a variety of factors regarding which we can have no exact knowledge.

On the other hand, *operation cannot be considered to be a simple, definite, and benign undertaking*. On several occasions it has happened that after the stomach was opened the ulcer could not be seen, but was found some days later at the autopsy: in five cases out of fifteen collected by Savariaud[5] the ulcer was not discovered. In one of Tuffier's patients, in spite of a large opening having been made into the stomach, it was impossible to discover the bleeding point; at the autopsy a very small ulcerated surface was with great difficulty discovered at the lesser curvature,[6] in which the gaping lumen of a small vessel could be seen. The ulcers of the fundus of the stomach and of the deep part of the duodenum are very inaccessible; those of the posterior gastric wall which have contracted adhesions with the pancreas are very ill-adapted for any direct hæmostatic manœuvres; the indurated pyloric ulcers may also entail very troublesome operations. What will be the nature of the operation? It is impossible to know beforehand. Where is the ulcer situated? Again it is impossible to say. The surgeon should be aware of these difficulties, which explain the very high post-operative mortality.[7]

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[1] Leube, "Die chirurgische Behandlung des Magengeschwürs." *Arch. f. klin. Chir.*, Bd. lv., 1, p. 69. and *Congrès de chir. allem.*, 21 avril, 1897.

[2] Mickulicz, *Ibid.*, p. 84.

[3] Hayem, *Académie de médicine*, jan., 1898.

[4] Absolutely nothing in the strictest sense. It may, however, do some good to give the patient, in teaspoonful doses, a solution containing 1 to 2 drs. of calcium chloride.

[5] Savariaud, "*De l'ulcère hémorragique de l'estomac et de son traitement chirurgical.* Thèse de doct., 1898.

[6] Tuffier. "Exulcératio simplex de l'estomac à grande hémorragie; gastro-entérostomie; mort." *Bull. de la Soc. de chir.*, 1902, 4 déc., p. 1166.

[7] Different authors give very different figures for this mortality. M. Hartmann estimates it at 63 per cent; MM. Tuffier and Jeanne, in a collection of fifty-two operations, found a mortality of only 37 per cent. ("Les gastrorragies dans l'ulcère simple de l'estomac." *Revue de chirurgie*, février, mars, avril, 1905.) Further, there seems reason for agreeing with MM. Mathieu and Roux ("Des indications opératoires dans les hémorragies de l'ulcère gastrique." *Gaz. des hôp.*, 23 avril, 1903, No. 48, p. 473), that "death has in the great majority of cases been due to collapse and not to the persistence of the bleeding, from which it may be inferred that the hæmorrhage would have ceased spontaneously, and the patient might have recovered but for the shock of operation. In some cases the operators have noted that the stomach was empty, or practically empty, of blood, and that the ulcer had stopped bleeding at the time of operation.

Lastly, we are sometimes called to see patients so intensely anæmic that any operative interference would be equivalent to certain and immediate death, for which we should deservedly bear the whole responsibility[1] should we attempt operation under such conditions. Therefore, in the case of a first hæmatemesis, even though considerable, do not lose confidence; keep the patient quietly in bed on his back, with the head low and the lower extremities raised on pillows; give him absolutely nothing by the mouth; keep an ice-bag constantly applied to the epigastrium; have rectal injections of boiled water administered two or three times daily, at a temperature of 120° F., and above all, employ very large quantities of saline solution, given subcutaneously, and, if necessary during the first few hours, into the veins.

A good deal may be expected from this method if thoroughly carried out; but be ready to operate if the bleeding recurs in the same quantity as before, or if the bleedings, although less, are repeated on several occasions,[2] are associated with fever, and rapidly produce a progressive and dangerous degree of anæmia. Do not forget that the very grave prognosis of these operations depends to a large degree on the late date at which they are undertaken and on the *incurable* anæmia of the patients.

TECHNIQUE OF OPERATION.

Certain general rules are applicable to these operations notwithstanding their complexity and varied characters. Rapid operation and the prevention of shock are of the greatest importance; the anæsthetic must be very carefully administered; the patient's limbs should be enveloped in cotton-wool, and if necessary encircled, after elevation, by elastic bands placed close to the trunk, with the object of retaining all the available blood in the system for the supply of the vital centres. Before the operation one to two pints of saline solution should be introduced into the veins or subcutaneously, and the infusion continued throughout the whole time of operation.

Open the abdomen through **a median incision above the umbilicus; a large incision is necessary,** because very free access is needed to enable the operator conveniently to explore and handle the stomach, which is often distended and adherent. The incision will therefore extend from the xiphisternum to, or even below, the umbilicus, and gauze compresses will be immediately placed under the lateral margins and lower angle of the wound to retain the intestines.

1. **Examination of the Exterior of the Stomach.**—The organ

[1] One must sometimes guard against drawing conclusions only from the appearance of the patient; the pulse is then the best guide: if it is very feeble and uncountable, if after injection of saline solution it recovers but little, and quickly falls off again, the vital powers must be considered to be very seriously impaired.

[2] Here is M. Dieulafoy's dictum: "Any patient who at one attack vomits from a pint to two pints of blood, particularly if the hæmatemesis recurs a second or a third time in the twenty-four hours, will almost certainly succumb if not operated on in time." (*Presse méd.*, 19 jan., 1898, p. 35, and *Clinique méd. de l'Hôtel-Dieu*, 1897–1898.)

is now visible, and with the aid of retractors[1] the anterior surface, the lesser curvature, a considerable part of the greater curvature, and the pylorus can all be examined.

Notice if there are any *adhesions* to the abdominal parieties, to the liver, or to the transverse colon; if any point presents *special coloration*, whitish or ecchymotic, which distinguishes it from the rest of the visible gastric wall; or if palpation indicates any *flat indurated area*. But do not depend on finding any of these external indications, nor stop short should the outward appearance of the stomach be perfectly normal: **it must always be opened.** The detection of a visible or palpable sign—adhesions, alteration in colour, or induration—furnishes a guide and indicates the point where the incision into the stomach should be made. If nothing has been discovered on the anterior aspect it will be well to examine the *posterior surface* at once in the following manner, as recommended by Savariaud: incise the gastro-colic omentum at an avascular spot close to the greater curvature below the gastro-epiploic artery, and enlarge the opening with the fingers; access is thus obtained to the lesser sac of the peritoneum, and through the opening three fingers or the whole hand may be introduced and can examine the entire posterior gastric surface (*Fig.* 358). This examination from the outside is, however, often negative; in any case do not spend much time over it, but open the stomach.

2. **Examination of the Interior of the Stomach.**—As preliminary gastric lavage has been impossible, the organ must be emptied[2] before it is incised; that is to say, after it has been drawn outside the abdomen and carefully surrounded with compresses, it will be evacuated with the trocar of an aspirating apparatus,[3] the puncture being made at a point through which the incision will afterwards pass. The gastric incision, like the parietal one, must be long (no adequate examination can be made with a single finger pushed through a narrow opening) and made longitudinally, parallel to the curvatures but nearer to the great curvature, unless some external sign has indicated the choice of some other area.

Now seize the two angles of the incision and the central points of the two lips with Kocher's forceps, by means of which the edges will be freely everted; this will give free access to the interior of the stomach, and, after having sponged up any remaining blood or gastric fluid, one can proceed to make a systematic examination of the walls with a gauze swab in one's hand.

If the bleeding has come from an old callous ulcer of the lesser curvature or on the posterior wall, or from a vessel of some calibre, it may happen that the lesion will be seen at once. Do not rely, however, on discovering it so speedily; often the ulcerations are comparatively recent and superficial, and the bleeding has temporarily ceased, and they must be sought for by

[1] And by raising the left lobe and anterior border of the liver.

[2] And gloves should be put on.

[3] That is the practice recommended by Terrier.

going over the mucous membrane bit by bit, wiping it gently with a gauze swab.

First explore the mucosa of the anterior wall by everting the edges of the wound, then the lesser curvature, which is to a great extent accessible, and then the posterior wall. In order to see this wall properly and to examine its folds, if it is not adherent it may be drawn out by two fingers introduced through the wound.

Or the manœuvre represented in *Fig.* 358 may advantageously be employed [1] : let an assistant introduce two fingers under the lower compress through an opening in the gastro-colic omentum, into the lesser sac behind

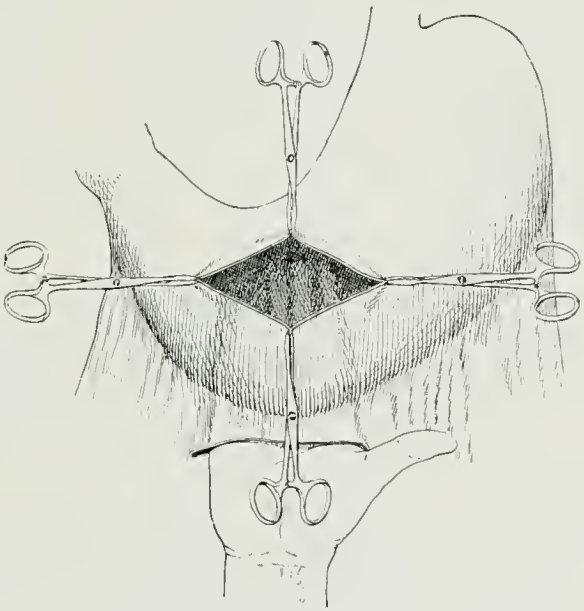

Fig. 358.—Examination of the mucous surface of the posterior wall of the stomach ; the hand is introduced into the lesser peritoneal sac behind the organ.

the stomach, or the surgeon himself may in the same way pass in two fingers of his own left hand, carefully enveloped in gauze, and with them push the posterior wall forward into the opening in the anterior wall ; in this way segment after segment may be exposed until the whole has been examined.

The pylorus, the cardia, and the fundus still remain. Carry the index finger to the pyloric orifice, which, if healthy, ought to admit it. If not, or if the pylorus is found to be thickened, indurated, and nodulated, then prolong the gastric incision towards it. Once the lesions are thus exposed, whatever steps appear necessary can be taken. To explore the cardia

[1] Of course, only if the lesser sac is free from adhesions.

and fundus two large retractors are introduced into the opening in the stomach: the one, superior, will raise the upper lip of the gastric wound and with it the left lobe of the liver; the other, lateral, will retract the wall to the left. The projection of the ribs and the variable depth of the sub-diaphragmatic region always make this a very difficult manœuvre.

It is impossible to insist too strongly on the necessity for a minute inspection of the whole of the mucous surface, wiping it gently with the gauze swab, particularly at any points at all abnormal in colour or appearance. This is the only way to avoid overlooking those quite superficial erosions which give rise to a large number of the fatal hæmorrhages.

3. **Hæmostasis.**—Here are the possible conditions which may be discovered during the course of the examination, and the appropriate hæmostatic procedures.

(*a*). **A typical non-adherent ulcer of the lesser curvature or one of the surfaces** has been found; in the base of this ulcer, after wiping it with a swab, a bleeding vessel is seen.

Excision of the ulcer followed by gastrorrhaphy is the surest method when the site and dimensions of the lesions permit.

Make two semilunar incisions around the ulcer and rapidly excise the enclosed segment. The cut edges bleed badly; compress one edge of the wound and apply pressure-forceps to the spouting vessels in the other; now repeat the manœuvre on the opposite side; put ligatures on the larger vessels: the smaller ones will be controlled by the suturing. Then close the opening at once by a continuous suture, including the whole thickness of the wall. If the stitches of this suture are placed close enough together and drawn sufficiently tight, all bleeding will cease. The closure will be completed by the application of a second continuous suture including the sero-muscular coats, and bringing broad serous surfaces together over the deep suture line. As far as possible the two incisions should be made in or parallel to the long axis of the stomach (*Fig.* 359), and the resulting gap closed at right angles.

If the ulcer is large, adherent, and difficult of access, and if excision would evidently be a long and difficult procedure, the best plan is, after having tied (if it is found) the vessel which has been the source of the bleeding, to free the borders all round and to bring their internal surfaces together by some interrupted sutures including their whole breadth down to the base of the ulcer.

In cases of ulcers situated at the curvatures, whether there is or is not an erosion of the coronary or gastro-epiploic arteries, forceps will be applied to the corresponding vessel (C, *Fig.* 359) above and below the area to be excised, and the omentum separated; then the excision and suture will be performed as before, and the forceps replaced by ligatures.[1]

[1] Roux and von Mickulicz have each obtained successful results by thus treating ulcers of the lesser curvature complicated by erosion of the coronary artery. Roux's patient (*Congrès français de chirurgie*, 1893, p. 401) was "a fat German brewer, who estimated his first hæmatemesis at 3 pints and the second at 4 pints; as a matter of fact he was almost bloodless. On

When the excision is impracticable, *double ligature of the artery, above and below the ulcer*, is a very useful measure. Roux adopted it in the case of a woman during a profuse hæmorrhage, with successful results, which were still maintained three years later.[1]

(*b*). **A chronic ulcer of the posterior wall, adherent to and eroding the pancreas,** is found; a large vessel is opened: the pyloric, the pancreatico-duodenal, perhaps the splenic.

The situation is extremely serious in a patient who has lost a quantity of blood, and who evidently could not survive a long operation.

The appropriate treatment is as follows: approach the adherent zone by way of the lesser peritoneal sac by raising the stomach, carefully separate

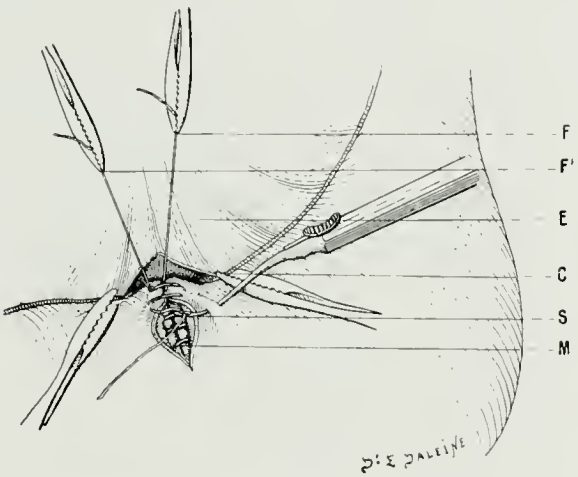

Fig. 359.—Sutnre after excision of an ulcer situated at the lesser curvature. (F) Initial end of the deep suture. (F') Initial end of the superficial suture. (E) Gastro-hepatic omentum. (C) Forceps on coronary artery. (S) Superficial, sero-muscular suture. (M) Deep suture (continuous).

the gastric wall, check any bleeding, and if necessary curette and cauterize the pancreatic focus; excise the margins of the ulcer and suture the opening. It is for the operator to judge if the patient's condition would justify such an attempt.

If not, he will then be compelled to limit his action to some very uncertain hæmostatic measures. An attempt may be made to seize the bleeding vessel with Kocher's forceps and to slip a mass ligature over the forceps; an effort may be made to find and ligature the two ends of the vessel. If no eroded vessel of any size can be found (in such a case careful scraping of the ulcerated area with a fine curette may be a help in discovering

the lesser curvature, not far from the pylorus, a circular circumscribed ulcer, which had eroded the coronary artery, was found. Double ligature of the artery, excision of the ulcerated area, and suture, were crowned with success." In Mickulicz' case (*loc. cit.*, p. 3) there was also an ulcer occupying the lesser curvature which had eroded the coronary artery. Excision and suture were followed by cure, which was still maintained three years later.

[1] Thèse de Savariaud, obs. viii.

the bleeding point) the ulcer will be cauterized with the thermo-cautery at a dull-red heat—a very untrustworthy method, which often simply postpones the danger and should only be employed under absolute necessity.

Perhaps it might be better to pass a series of interrupted catgut sutures around the ulcer and deeply into the pancreatic tissue, which would, when gently tied, exercise pressure on the bleeding area.

(*c*). **Ulcer of the pylorus or duodenum.**—Should this be small, not adherent, not complicated by stenosis or extensive induration, **it will be excised.** As far as possible the excision should be made transversely in the long axis of the canal, and the edges of the resulting opening sutured together vertically.

When the pylorus is stenosed and considerably thickened, **pylorectomy** might be performed ; but under urgent conditions an operation of that kind

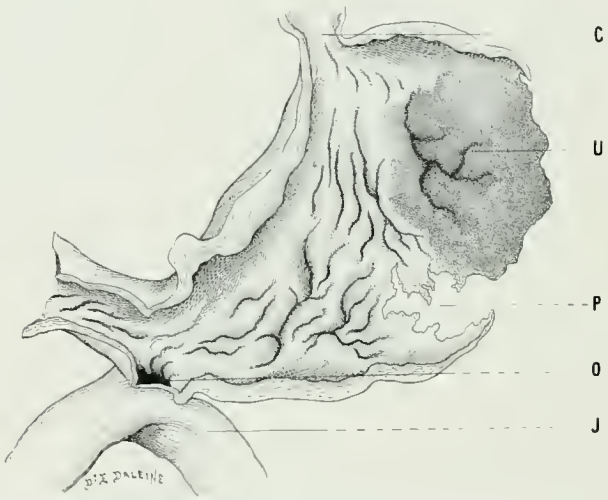

Fig. 360.—Large perforating ulcer of the fundus of the stomach (gastro-enterostomy.) (C) Cardiac orifice. (U) Ulcer. (P) Perforation. (O) Gastro-intestinal opening. (J) Loop of jejunum.

would be scarcely justifiable ; it would be much better to cauterize the ulcer freely, to ligature the pyloric artery, and perform gastro-enterostomy, which may be done very quickly.[1]

Lastly, it must be admitted that there are some cases which are absolutely hopeless, no matter what is done ; lesions are sometimes found of such a character that no procedure could be attended by satisfactory and lasting results. As for instance, in the patient whose stomach is represented in *Fig.* 360.

This case had been under treatment the previous year for symptoms of serious ulceration of the stomach ; subsequently the pain, the digestive

[1] But this gives uncertain results in cases of profuse hæmorrhage.

disturbances, and the hæmatemesis had recurred from time to time, and latterly had never ceased. She was readmitted into M. Fernet's service, vomiting considerable quantities of blood and in a condition of extreme anæmia. I performed laparotomy, and found the stomach universally thickened and indurated and everywhere adherent. I made a small opening into it, but as the patient's condition was extremely bad, I was obliged to content myself with very rapidly performing an anterior gastro-enterostomy. The poor patient lived for some days without any further hæmorrhage, and then died from exhaustion.

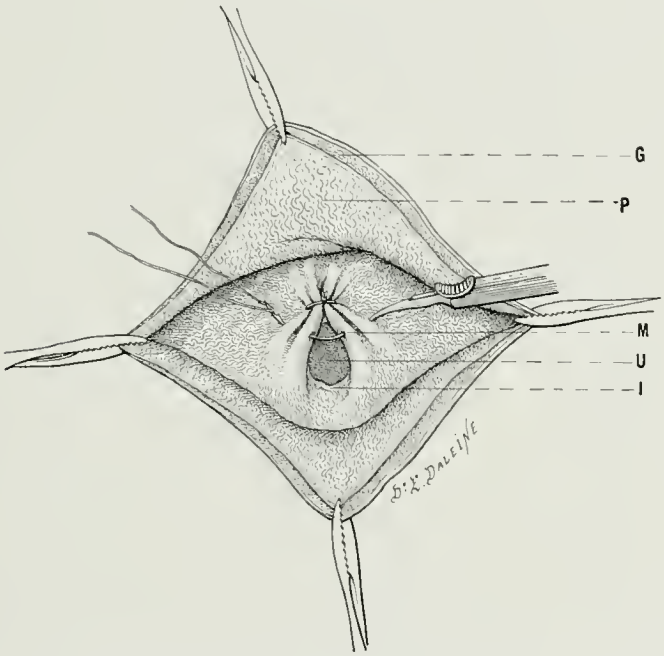

Fig. 361.—Hæmostasis by suturing a superficial ulcer. (G) Upper edge of the gastric incision. (P) Internal surface of the stomach. (M) Needle picking up double folds of the mucous membrane on each side of the ulcer. (U) Ulcer. (I) Inferior border of the ulcerated surface.

At the autopsy, the gastric wall in the whole of the right portion of the organ was found to be about half an inch in thickness: the central portion of the fundus was occupied by a large ulcerated area in which there was a gaping perforation with ragged gangrenous borders (P, *Fig.* 360), which opened into a cavity filled with old clot and necrotic débris, occupying the inner surface of the spleen. What could we have done in such circumstances? Gastro-enterostomy was the only practicable operation.

(*d*). **Superficial ulcers, exulceratio simplex.**—Here the great difficulty lies in discovering the ulcer, which is a mere abrasion or erosion. If found, the bleeding can be controlled by passing a series of sutures in the manner shown in *Fig.* 361: **a fold of mucous membrane on each side of the bleeding area** is brought together over the ulcer in the same way that

the folds of the sero-muscular coats are approximated in performing a serous suture; it is a good plan to pick up double folds of the mucosa on either side, and to include a good thickness of the underlying muscular coat, thus getting a sufficient hold on the tissues to allow the sutures to be tied tight enough to exert adequate pressure on the bleeding area without risk of cutting out. Or again, though less satisfactorily, the bleeding point may be seized with forceps and a cone of the mucous membrane lifted up, around the base of which a ligature *en masse* is then tied.

The former plan was successfully employed by Cazin in the case of Dieulafoy's patient. "An incision 4 inches long was made on the anterior surface of the stomach, parallel to the curvatures and rather nearer to the lesser curvature; and the operator turned the stomach inside out, like the finger of a glove, to facilitate the exploration. The stomach was empty; it contained neither blood nor fluid, and there was no apparent ulcer. . . . M. Cazin very carefully wiped the mucosa with a gauze swab, and finally discovered a small bleeding spot, about the size of a sixpence, situated on the posterior surface, not far from the upper end of the organ. On lightly rubbing the eroded surface with a swab, hæmorrhage immediately appeared over an area as large as a five-shilling piece. By means of several transmucous catgut sutures the whole of the bleeding surface was turned in a sort of fold. After making sure that the hæmorrhage was definitely stopped, the wound in the wall of the stomach was closed by three layers of sutures.[1]

(*c*). Lastly, **no lesion whatever** may be found, notwithstanding the most careful examination of the mucous surface of the stomach. This has occurred several times, and it is necessary to be warned of the possibility. Should the incision simply be closed, trusting that the temporary hæmostasis may become permanent? No! Nor should the edges of the gastric incision be sutured to the parietal wound, as Salzer has done in one case, with the idea of subsequently being able to effect hæmostasis by way of the channel thus retained. The best plan is to perform rapidly an **anterior gastro-enterostomy,** using for the sake of simplicity the already existing exploratory opening in the stomach.

As a primary procedure *gastro-enterostomy*, posterior or anterior, according to the freedom or otherwise of the stomach from adhesions, finds its indications[2] when serious gastric hæmorrhage occurs in a patient who has previously presented the signs of pyloric stenosis, or when the general condition is too bad to justify intragastric exploration and manipulations of uncertain duration.

[1] Dieulafoy, *loc. cit.*

[2] Although gastro-enterostomy has been employed with fair success in dealing with severe hæmatemesis (MM. Tuffier and Jeanne, *loc. cit.*, have collected seventeen cases with ten successes), it must not be forgotten that it is only an indirect method and does not always prevent the recurrence of the bleeding. (See QUÉNU, "Ulcère simple hémorragique: gastro-entérostomie postérieure: mort par hémorragie foudroyante." *Bull. de la Soc. de chir.*, 1904, p. 305 and 447, and the subsequent discussion.) As a practical rule one can say this: After an acute hæmorrhage from an ulcer, treat the patient strictly on the non-operative lines laid down above; very often this will succeed in averting immediate danger; as soon as the patient is in sufficiently good condition, perform gastro-enterostomy.

GASTROSTOMY.

In the case of a patient who is greatly emaciated and who is actually "dying of starvation," gastrostomy becomes an urgent operation in the strict sense of the term. Of course, a case ought never to be allowed to drift into such a condition from cancer or impassable stricture of the œsophagus before the necessary operation is performed, especially as the operation is so simple and gives excellent results when performed early; still, as a matter of fact, these cases of extreme inanition are by no means uncommon, and the immediate opening of the stomach may be required at times as a last resort.

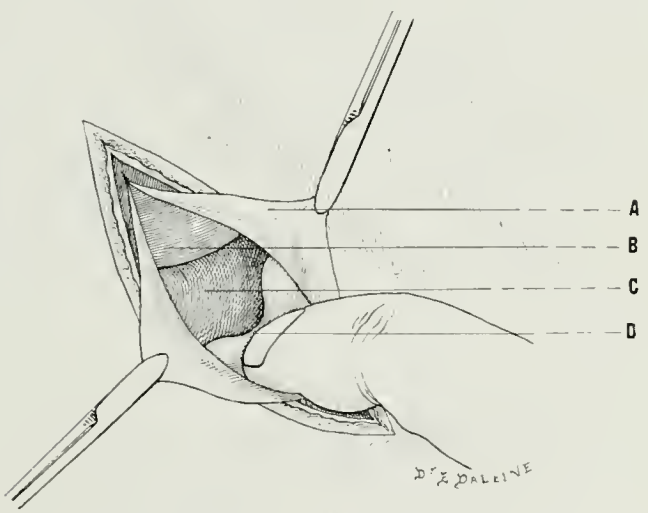

Fig. 362.—Gastrostomy. First step: Incision parallel to the costal border and search for the stomach. (A) Parietal peritoneum secured with forceps. (B) Left lobe of the liver. (C) Stomach. (D) Transverse colon pushed down with the finger.

Remember, it is essential that these operations should be very rapidly performed; avoid general anæsthesia in a cachectic patient whose life is, if I may say so, already trembling in the balance: in such conditions cocaine is indicated.

The gastrostomy opening ought to be made as close as possible to the cardiac end of the stomach, and it ought to be very small; these are the two fundamental rules which govern the operation, and if they are duly observed it will be possible to obtain a continent orifice by means of a simple and rapid procedure.

A scalpel, a pair of dissecting forceps, a pair of Kocher's forceps, some pressure-forceps, Reverdin's intestinal needle or an ordinary fine suture needle are all the instruments required, with some catgut or silk No. 0 and No. 1, and some silkworm gut.

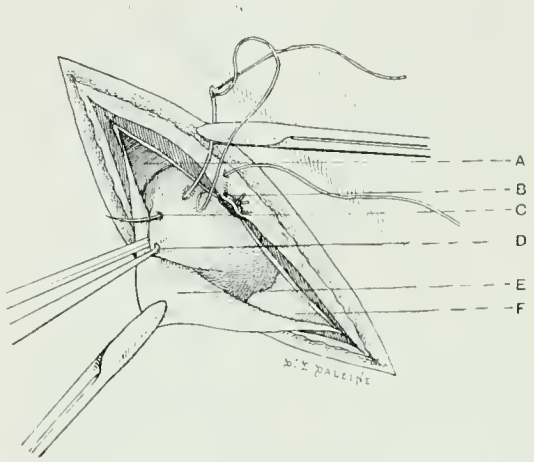

Fig. 363.—Gastrostomy. Second step: Fixation of the gastric cone to the abdominal wall. (A) Left lobe of the liver. (B) Lateral U-Suture, knotted. (C) Needle passing the axial suture through the sero-muscular coat of the stomach. (D) Forceps holding the apex of the gastric cone. (E) Parietal peritoneum. (F) Transverse colon.

The operation field having been prepared in the usual manner, determine the position of the left costal border (which always projects prominently in these emaciated patients), the xiphisternum, and the cartilage of the 9th rib. Make an incision three inches in length, parallel to, and an inch to the inner side of, the costal border, extending from two inches below the xiphisternum to the level of the 9th rib. Without delaying over the small arterioles, which will presently be caught and twisted, cut down steadily through the different layers of the abdominal wall; the skin, the superficial aponeurosis, a first thick muscular layer (the rectus), a second thinner muscular layer (the transversalis). Then the deep fibro-serous aponeurosis is exposed. Lift it up with the forceps, open it, and then divide it on the finger to the extremities of the superficial wound and immediately secure the edges with two forceps. The left lobe of the liver will now be visible; raise it up; the stomach lies below. Sometimes in these cases the stomach is retracted and hidden by the transverse colon; if so, push down the colon with the finger, raise the border of the liver, and the stomach is then exposed. It is easily recognized by its consistence and appearance. Its wall is thick, and gives a sensation quite different from that of the intestine; it is greyish-white in colour,

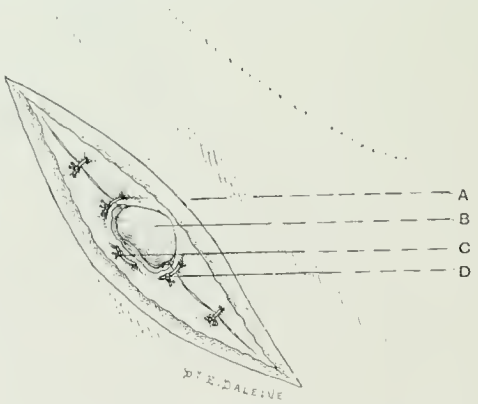

Fig. 364.—Gastrostomy. The gastric cone has been fixed to the abdominal wall and is ready to be incised. (A, D) Axial sutures. (B) Gastric cone. (C) Lateral suture.

smooth, and streaked with small vessels, running vertically towards the vascular arch at the lesser curvature.

With two fingers take hold of a fold of the anterior gastric wall and test the mobility of the organ; if it can be easily raised and brought up into the wound, then seize it as high up as possible and near to the lesser curvature with the Kocher's forceps, and draw a small cone of the wall outside the wound. If the stomach is much retracted, indurated, and adherent, and does not come up readily, apply the forceps lower down, nearer to the middle line, because it is essential that the cone should be of sufficient size, and that it should be possible to fix it to the abdominal parieties without undue tension or dragging.

Now fix the cone to the lips of the parietal wound by four sutures of fine silk, two lateral and two axial, passed as shown in *Fig.* 363, picking up on the one hand the sero-muscular coats of the stomach, and on the other

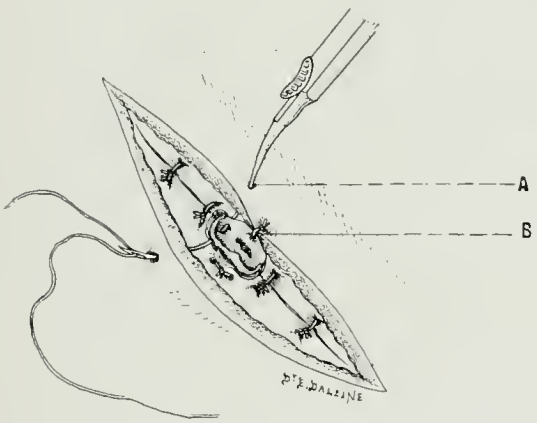

Fig. 365.—Gastrostomy. Third step: Incision of the cone; suturing the mucous edges to the skin. (A) Needle introducing one of the axial sutures. (B) Lateral suture.

Fig. 366.—Gastrostomy. The operation completed; small orifice bordered by mucous membrane; parietal wound sutured.

the whole thickness of the abdominal wall from the peritoneum to the superficial aponeurosis. Then close the parietal wound above and below the stomach with one or two points of suture (*Fig.* 364). The stomach must now be opened. Make an incision about a quarter of an inch in length at the apex of the cone with the point of the scalpel. Remember that the gastric mucosa is very lax and very mobile, and may slip away in front of the knife and not be opened at the first stab; grasp the plicated membrane which you see at the bottom of the little wound with the dissecting forceps, and puncture it with the point of the knife. The greyish mucous membrane will at once pout into the wound, and some gas and a little fluid, which must be wiped up at once, will escape.

Now attach the mucous margins of the little opening to the skin by four sutures of fine catgut (*Fig.* 365); a few cutaneous sutures in the rest of the wound will then finish the operation.

There has thus been provided a narrow mucous ring, accurately sutured to the skin, and at its centre an opening just sufficient to admit a No. 6 or No. 7 catheter. Do nothing more; simply apply a dry aseptic dressing. The catheter will only be introduced at the time of feeding.

At the end of four or five hours the first meal of milk may be given; sometimes, however, if the patient's condition is very bad, it will be advisable to introduce some fluid nourishment into the stomach as soon as the operation is completed.

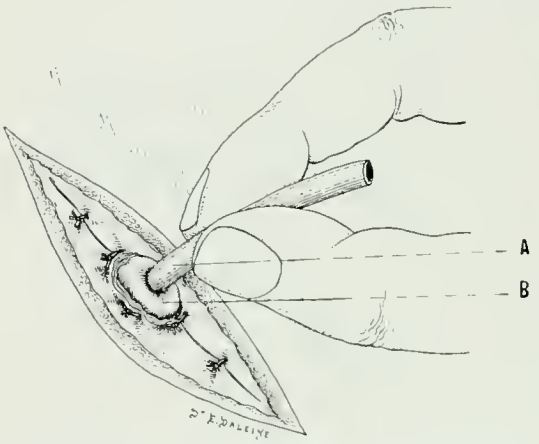

Fig. 367.—Gastrostomy (Fontan's method). The catheter has been introduced into the small opening in the apex of the cone; the margins of the opening grip the catheter, and as the latter is pushed on the cone is inverted. (A) Catheter. (B) Gastric cone in process of inversion.

This is an excellent operation; it has the great advantage of rapidity, and at the same time is in the end quite as good functionally as the more complicated methods, that is, provided the feeds are always administered through a small-sized catheter, insinuated very gently into the opening, if they are given slowly and in very gradually increasing quantities, and if the region is properly protected from external irritation by a suitable dressing.

Once the cone of stomach has been fixed to the abdominal wall it may often be possible, without requiring any more time for its performance, to complete the operation by Fontan's method, modifying the second step of the operation as follows:—

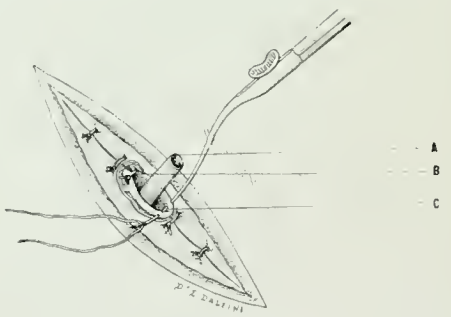

Fig. 368.—Gastrostomy (Fontan's method). The gastric cone is inverted like a funnel and the fold is fixed by two axial sutures. (A) Catheter in the opening. (B) Axial suture already knotted, uniting the inverted walls of the cone and maintaining inversion. (C) Second axial suture being introduced.

Make a small puncture through the apex of the cone, just sufficient to admit the tip of a No. 6 catheter with some resistance; by pushing in the catheter,[1] the little

[1] This is really a slight modification of Fontan's method. In the original manœuvre the invagination of the cone is produced by pushing in the forceps which grasp the apex; the puncture is then made with a narrow scalpel at the bottom of the inverted cone, and the catheter introduced.

cone is depressed (*Fig.* 367) into the interior of the stomach; it only then remains to fix it by two Lembert sutures at B and C (*Fig.* 368), and there is produced a funnel-shaped opening the circumference of which acts as a valve.[1]

FOREIGN BODIES IN THE STOMACH.

It is a well-known fact that foreign bodies may pass into the intestines from the stomach more or less quickly, and be spontaneously eliminated; and also that their sojourn in the stomach, even if prolonged to months or years, sometimes gives rise to no serious trouble.

Therefore urgent indications present themselves only in some comparatively rare conditions:[2] (1) *Immediately after an object has been swallowed of such size and such superficial characters as to render its passage into the intestine impossible, and the occurrence of serious gastric lesions probable;* and (2) *In cases of perigastric suppuration consecutive to slow perforation of the wall.*

1. Although instances are not lacking of comparatively large, irregular, or even pointed objects having traversed the whole length of the alimentary tract without causing damage, it is practically impossible to depend on such a fortunate outcome in any particular case. Primary action must vary according to the nature of the object (if indeed this is known, and if certain it is actually in the stomach): emesis may be useful in the case of comparatively small, rounded and smooth bodies, as may gastric lavage in the same conditions. When dealing, however, with a long, rigid rod, or a branched and pointed object, the gastric contractions provoked by vomiting would not be free from danger.[3] Therefore, in such circumstances gastrotomy is indicated, and should be performed as soon as possible.

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[1] Because of its simplicity we may here mention P. Poirier's method: Oblique incision parallel to the costal border; withdrawal of a cone of the anterior gastric wall; fixation of the cone in the parietal wound by four sutures traversing the peritoneum and deep muscular layer of abdominal wall; incision ½ inch in length through the sero-muscular coats at the apex of the cone; free separation of the mucous membrane, which is then perforated with a director to allow the introduction of a No. 8 catheter; closure of the abdominal wall, and suture of the skin, to which the edges of the sero-muscular incision in the stomach are united by four sutures. The mucous membrane, inverted and hanging free, acts as a valve at the bottom of the track. (*Bull. de la Soc. de chir.*, 8 mai, 1900, p. 475.) The number of attractive methods is considerable, but after having tried several, we always return to the general rule already formulated: *the opening as high as possible and as small as possible*; those are the necessary conditions for a satisfactory gastrostomy. Sooner or later the oblique tracks straighten out and the valves become incompetent. If time is not of capital importance, Marwedel's method is still the one which appears to give the best results. (See Barozzi, "*Considérations sur la gastrostomie en général et sur le procédé de Marwedel en particulier, dans les sténoses cancéreuses de l'œsophage.*" Thèse de doct., 1898.)

[2] For the majority of foreign bodies in the stomach the "soft food treatment" is the best, at least in the early days of the case; the patient will be instructed to take a superabundance of thick potato soups, milk puddings, etc., with the idea of forming a protective coating around the foreign body (pins for instance) and distending the alimentary canal; the best results will usually be obtained by this simple method.

[3] Mathieu, "Corps étrangers de l'estomac." *Gaz. des hôp.*, 23 sept., 1897, p. 1065.

For instance, a lunatic 67 years of age had swallowed a tooth-brush ; he was taken to M. Hildebrandt's clinique.[1] A radiogram was at once taken, and showed the foreign body lying to the left of the vertebral column, at the level of the lower dorsal vertebræ. Laparotomy was immediately performed, the stomach was drawn outside the abdomen and incised, and the brush found and extracted. The gastric and parietal wounds were closed, the patient making an uninterrupted recovery.

The following are the steps of a gastrotomy performed for a foreign body : median supra-umbilical laparotomy ; the stomach is recognized, and, by palpation through its wall, the position of the foreign body is determined ; if fixed and prominent, the stomach will be opened in front of it ; if movable, the best plan will be to incise the gastric wall about the middle of its anterior surface, to the left of the median line.

A segment of the anterior gastric wall is drawn out through the parietal wound, secured with two pairs of small forceps, surrounded carefully with gauze compresses, and incised in the long axis of the stomach, rather nearer to the greater than the lesser curvature. Only a short incision is needed, 1½ to 2 ins. long as a rule. Any bleeding arteries in the cut edges are seized with forceps ; then the lips of the opening are retracted and

Fig. 369.—Throat swab removed from the stomach by the incision of an epigastric abscess.

blunt-ended forceps introduced into the cavity to seek for the foreign body, which, when grasped, will be inclined in the direction which will most facilitate its extraction ; a finger should not be introduced except in case of necessity, and then only after having put a glove on the corresponding hand. After the extraction is achieved the glove will be removed.

It now only remains to close the stomach with continuous sutures in two layers, a deep layer including the whole thickness of the wall, and a superficial layer including the sero-muscular coats.

2. Operation may become necessary at a later date, owing to the formation of an *anterior perigastric abscess*, consecutive to slow perforation of the gastric wall by the foreign body.

In such a case the incision should be kept strictly within the limits of the swollen and suppurating area, and the cavity must be very cautiously opened up : at the bottom the end of the foreign body will usually be encountered, and will be seized and extracted with suitable forceps. Nothing more should be done ; the gastric fistula will usually close spontaneously.

Fig. 369 shows a throat swab which we removed in this manner from the stomach of an old man 76 years of age.[2]

[1] Neuhaus, "Fremdkörper im Magen und in der Speiseröhre." *Arch. f. klin. Chir.*, 1908, lxxxvi., 1, p. 245.

[2] "Corps étranger de l'estomac : phlegmon épigastrique : extraction par l'incision : guérison simple." *Soc. de chir.*, 19 décembre, 1906, p. 1123.

JEJUNOSTOMY.

A man 65 years of age, pale, emaciated and cachectic, had suffered for many months with all the symptoms of cancerous stenosis of the pylorus; he was in a most lamentable condition; the ingestion of even the smallest quantity of nourishment by the mouth was followed by most intense pain, which was also aroused by the frequent vomiting of blood. I wished to do something to relieve his sufferings; I opened the abdomen in the middle line above the umbilicus, and found a large stomach diffusely infiltrated with malignant disease and everywhere adherent. What was to be done? Close the wound and have recourse to enormous doses of opium, as quite large quantities were even now insufficient to give relief? It seemed to me more reasonable to draw a loop of jejunum into the wound and to make a fistula in the way which I shall immediately describe, and thus provide a subgastric channel for the introduction of nourishment and at the same time, by putting the stomach at rest, relieve the intolerable pain. The desired relief was obtained, but the patient only lived for a few weeks.

Jejunostomy in cancer cases is, like gastrostomy, simply a palliative operation practised for the relief of pain and the administration of adequate nourishment.

Notwithstanding Maydl's recommendation, it is much inferior to gastro-enterostomy; indeed, it finds its indications in the contraindications to the latter, or, in other words, in the conditions which make gastro-enterostomy impossible. Therefore it is not a brilliant operation; but although the results are scarcely flattering to the surgeon, it must only be judged by the degree of functional benefit it confers on a patient who is in any case incurable.

In 44 cases operated on in M. von Eiselberg's clinique[1] there were 14 operation deaths, a mortality of 32·5 per cent; 8 patients succumbed before the end of the first month; 5 lived for two months; 5 for three months; 3 for four months; 1 five months; 2 eight months; 1 nine months; which gives an average survival of 66 days, a sixth only of all the patients operated on living for more than four months after the operation.

Still, jejunostomy is occasionally useful, and ought to be known. Even in the relatively urgent conditions we have in view, diffuse cancerous infiltration of the stomach or universal adhesions of the gastric wall—which would entail a difficult preliminary separation before any portion of the organ could be freed for anastomosis with the jejunum—often permit of no doubt as to the plan which must be followed,[2] apart altogether

[1] H. Lempp, "Ueber den Werth der Jejunostomie." *Arch. f. klin. Chir.*, 1905, lxxvi., 1–2, p. 323.

[2] Jejunostomy may also be the only available procedure in some other cancerous conditions. I refer to the cases where, with a cancerous growth of the cardiac portion of the stomach or of the lower end of the œsophagus, the stomach is found so much retracted and atrophied that a satisfactory gastrostomy is hardly possible; to the very exceptional condition of double cancer of the stomach, at the pyloric and cardiac orifices; and to the cancerous perforations complicated by perigastric suppuration. Jejunostomy may also be useful in cases of extensive

from the cases in which the general conditions are too bad to permit of any other operative procedure.

Technique.—Under the usual conditions which call for it, jejunostomy is only justifiable if it can be simply and rapidly performed.

The operator may content himself with fixing a jejunal loop to the abdominal wall and making a very small opening in it; that is simply an

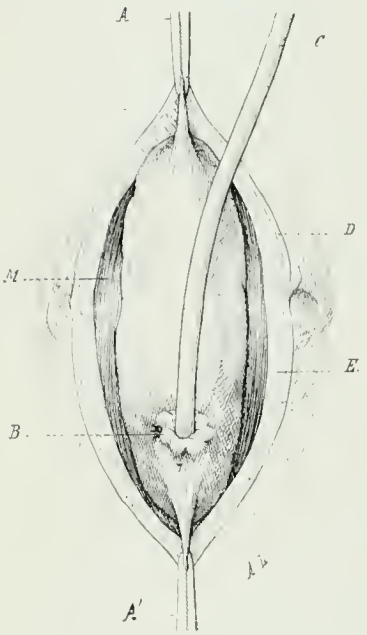

Fig. 370. Jejunostomy. First step: The loop is arranged longitudinally and secured by two forceps; the catheter is passed into the intestine, and the opening closed around it by a purse-string suture of catgut. (*AA'*) Forceps fixing the two extremities of the loop. (*B*) Intestinal wall, closed round the catheter by purse-string suture. (*C*) Soft rubber catheter. (*D*) Skin. (*E*) Aponeurosis. (*M*) Rectus muscle.

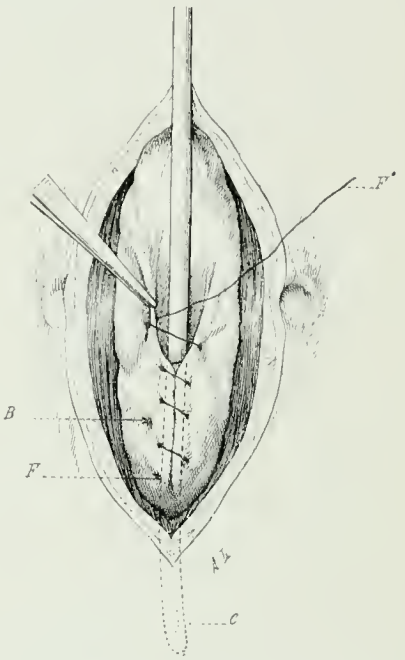

Fig. 371. Jejunostomy. Second step: Burying the catheter under a double fold of the intestinal wall. (*B*) Knot of the purse-string suture. (*C*) Intra-intestinal extremity of the catheter. (*FF'*) Continuous suture uniting the two folds of the intestinal wall.

ordinary enterostomy on the jejunum. But it is not a satisfactory method, because the orifice is by no means always continent, or at any rate not for long, and then the leakage renders it useless, and at the same time sets up cutaneous irritation and pain.

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burns of the stomach and œsophagus, either after cicatrization, when inanition is threatening, and the stomach is so deformed and sclerosed that a gastro-enterostomy is impossible, or during the acute stage, when the ulcerative gastritis resists all medical treatment and it is essential to secure rest for the stomach. Lastly, other indications may be found in certain forms of gastric ulcer; and although the question is, strictly speaking, outside the limits of urgent surgery, it is worth while noting that jejunostomy has been employed in cases of serious hæmatemesis when gastro-enterostomy seemed to be impracticable, and that it has several times given good results. (Von Eiselberg.)

By Maydl's method—jejunostomy in Y—in which a loop situated about 8 ins. from the duodeno-jejunal flexure is taken, divided at its centre, the upper cut end implanted into the side of the distal segment about 10 to 12 inches below the point of section, and the lower cut end sutured to the abdominal wall, excellent results are undoubtedly obtained: but it cannot be denied that it is a somewhat complex procedure, and outside the scope of the conditions we have laid down for this volume.

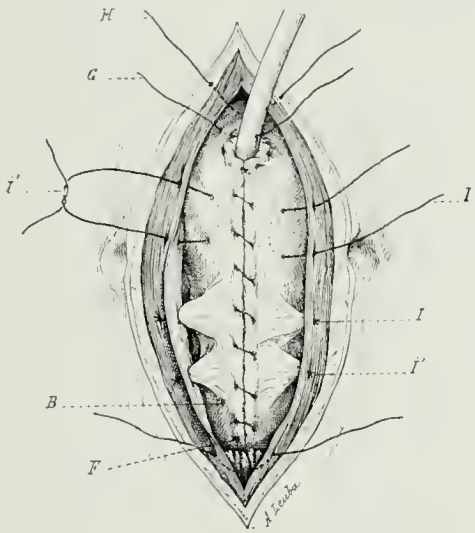

Fig. 372.—Jejunostomy. Third step: Fixation of the loop to the abdominal wall. (*B*) Knot of the purse-string suture. (*F*) Continuous suture uniting the two folds of the intestinal wall. (*G*) Suture of fine catgut fixing the catheter at its point of emergence from the intestinal wall. (*H*) Upper transverse suture. (*H'*) Lateral U-sutures.

Fig. 373.—Jejunostomy. Fourth step. Suture of the abdominal wall. (*H*) Upper transverse suture (*KK'*) Continuous suture uniting the abdominal wall.

Therefore von Eiselberg's method is to be preferred. Open the abdomen in the middle line by an incision from 4 to 6 inches long, with its centre at the umbilicus. Go to the left side of the vertebral column, internal to the descending colon and below the transverse colon, and look for the first loop of the jejunum which is fixed above at the duodeno-jejunal flexure: at about 8 inches below the flexure secure a loop 4 inches in length, bring it outside the abdomen, and isolate it with aseptic compresses. Arrange it longitudinally in the long axis of the parietal wound, and fix it with a pair of Kocher's forceps applied at each end on the antimesenteric border; the forceps should grasp only the outer coats of the gut.

At the lower end of the loop, immediately above the lower fixation-forceps, make a puncture with the point of the scalpel through the wall of the gut, just large enough to admit a No. 8 soft rubber catheter; push the distal end of the catheter 3 or 4 inches into the interior of the intestine, then close the opening in the gut around the catheter with a purse-string suture of fine catgut (*Fig.* 370). Then the free portion of the catheter is applied

longitudinally to the jejunal loop from below upwards, and buried by suturing two folds of the wall over it with a continuous suture (*Fig.* 371). Thus a vertically placed tunnel is formed in the wall of the gut around the catheter.

The loop may be fixed to the abdominal wall simply by two transverse sutures, the one at the lower end, the other at the upper ; it will, however, prolong the operation very little to introduce also two or three lateral sutures (*Fig.* 372), and these additional sutures will have the advantage of securely maintaining the proper direction of the loop. Lastly, the abdominal wound will be sutured (*Fig.* 373).

Fig. 374.—Jejunostomy : Introducing the tube, preparatory to feeding.

Let us add that the catheter should be fixed at its point of emergence from the tunnel in the wall of the intestine by a fine catgut suture passing through its wall and through the adjacent part of the sero-muscular coat of the intestine. The catheter ought to be left in position as long as possible ; in one of my cases I only withdrew it at the end of two months ; there was then a satisfactory channel of adequate calibre and vertical direction, through which the catheter was easily introduced for feeding purposes (*Fig.* 374).

A small quantity of milk may be introduced into the intestine on the same day as the operation ; it is advisable to administer the first feeds cautiously, testing the retentive capacity of the intestine and not injecting more than 8 or 10 oz. at a time, repeated several times daily. The dosage may be increased, more or less quickly, to one or two pints. Jejunal feeding ought of course to be purely liquid at first, milk with raw eggs and peptones forming the basis ; later, meat broths or vegetable soups may be added.

INTESTINAL OBSTRUCTION.

Acute Obstruction.—A strong, healthy young farm labourer was suddenly attacked some hours after his evening meal with a violent pain in the abdomen, a sort of intense colic, accompanied with cold sweats, nausea, and pallor. Soon he began to vomit, and during the whole night the vomiting, the pains, and the abdominal colic continued. On the evening of the second day he seemed a little easier, but the abdomen was considerably distended, the bowels had not moved nor had flatus been passed since the day before, and unfortunately a purgative was administered.

During the night the situation altered seriously for the worse ; next morning, the pinched face, wretched pulse, and coldness of the extremities, the fæcal vomiting, the distention of the abdomen, and the persistent and absolute constipation, allowed no misconception as to the fast approaching

termination. However, a last attempt was made: a large infusion of saline solution was given, and under very light anæsthesia the abdomen was opened: a volvulus of the sigmoid colon was found at once and reduced without trouble; but while the abdomen was being closed the patient died. The operation had not lasted ten minutes, but the toxæmia was too great, and the time had passed for any useful intervention.

This is an example of acute obstruction in its most typical and evident form; later on we shall return to the details of the case.

Another example: A breast-fed child, four months old, was brought to the Laënnac Hospital; for thirty-six hours it had passed neither fæces nor flatus, and after each feed it had almost immediately vomited the milk just taken, mixed with greenish fœtid material: since the night previous a fairly considerable quantity of blood had from time to time been discharged from the anus. The pulse was extremely fast, and the face pinched. In the left flank an elongated, firm, and mobile swelling was felt. A diagnosis of intussusception was made, and, as a matter of fact, there was an ileo-colic intussusception 10 inches long and already gangrenous.

Still another example: A patient under treatment for old-standing coxalgia was suddenly attacked with vomiting; anything taken by the mouth was almost immediately returned. The bowels moved once during the day, then obstruction became complete. However, no distention of the abdomen developed except in the supra-umbilical region. The face altered and the pulse weakened rapidly. Laparotomy was performed, and a thick band strangling the commencement of the jejunum was found (*Fig.* 378).

It would serve no good purpose to multiply illustrative cases. In the typically acute form, which I intend to discuss first of all, the symptoms present themselves, when properly investigated, with a definiteness which allows no misconception. The clinical characters of this true ileus proceed from two factors which are always combined: **sudden complete fæcal stoppage**, and **stercoræmia.**

In the majority of cases the onset occurs suddenly, without any premonitory symptoms, during a period of perfect health, and is usually indicated by an attack of very severe pain, followed almost immediately by nausea and vomiting.

The capital sign is **complete fæcal stoppage**—that is, *neither fæces nor flatus are passed by the bowel.* That is the point which must be investigated and verified. Too much stress has been laid in the past on that emptying of the lower segment of the alimentary canal which it is said continues for some time after complete mechanical obstruction has been established, and the old statement has been copied from book to book, and, what is worse, has been imprinted on the memories of generation after generation of medical practitioners, always in association with another formula of which we shall again have cause to speak: fæcal vomiting is the pathognomic sign of intestinal obstruction. The statement is true undoubtedly in a general sense, but the serious, nay, the disastrous, result is the tendency to make fæcal vomiting a necessary element in the diagnosis.

It may happen that the patient in the early hours of the illness passes some fæcal matter by the anus, but in true complete obstruction, such an occurrence is only an initial and transitory incident; the obstruction is absolute and permanent: nothing passes.

On the other hand, **one must never wait for the appearance of fæcal vomiting**: for one reason because it may never appear; the third patient whose history is recorded above, in whom the small intestine was strangled at the origin of the jejunum, would never have vomited fæcal matter; his vomit was green and bilious, and would have remained the same till the end. And besides, the stage at which fæcal vomiting appears varies according to the height at which the obstacle is placed and according to the degree of atony of the intestinal musculature; when it does appear, it always indicates a general condition which is already extremely grave, and it is always associated with profound stercoræmia.[1]

In short, **a patient suffering with complete obstruction passes neither fæces nor flatus, and vomits everything he takes**: that is to my mind the practical diagnostic rule, which is confirmed and completed by the special signs of septic absorption and by the state of the abdomen.

As soon as obstruction is established, septic absorption begins. I do not wish to enter into a discussion of the mechanism and nature of the general reactions produced by intestinal strangulation; it is a difficult and obscure subject, in the consideration of which attention must be given to the mechanical influences exerted on the sympathetic plexus and to colon-bacterial infection. I can only refer to the experiments which I shall mention later on under STRANGULATED HERNIA, and which have demonstrated that the strangulated loop becomes paralyzed and distended, and its wall soon becomes permeable by intestinal microbes, thus opening a channel for their diffusion into the vessels in the wall and into the peritoneum.

The resulting septic intoxication increases hourly, and soon renders itself evident by quite special symptoms: the pale, drawn face, and sunken eyes, the purple mottling over the cheek-bones, the very rapid pulse (120, 130, and even more), very feeble, soft, irregular and intermittent, the coldness of the extremities and of the nose and tongue, the purple coloration of the skin, the subnormal temperature, the rapid shallow respiration. The clinical picture is only complete in the advanced stages, but from the beginning the pulse and the face are indicative.

Lastly, direct your attention to the abdomen: **it is distended, rigid, resonant, and painful at some point**; but you do not find that diffuse superficial tenderness which indicates peritonitis. The distention hourly becomes greater, or if the increase in actual volume is comparatively slow, at least the tension becomes more marked; palpation gives a

[1] Stercoraceous fluid is often found in the stomach at a very early stage. An examination of the gastric contents by means of the stomach tube may be at times of considerable diagnostic value. (EWALD.)

sensation of loaded intestines filling the abdomen and pushing forwards against the wall.

It is not always possible to obtain definite information as to the situation and nature of the obstruction from an examination. The signs which we shall study immediately must be looked for, but do not trust too much to them. From the time they first appear, one has in the *complete fæcal stoppage, in the signs of stercoræmia and the increasing distention of the abdomen*, all the points necessary for making the diagnosis of acute obstruction, and from which to draw the necessary practical conclusions. What are these conclusions? What is to be done? The first duty is to lose no time: the general toxæmia is increasing steadily, and the vital resistance and chances of recovery are correspondingly decreasing. Before going further, I wish to say a few words with regard to this toxæmia. There has been too great a tendency to look upon intestinal obstruction as a mechanical question; one says, the intestine is strangulated, the wall is in danger of becoming gangrenous, perforation will occur, and then general peritonitis. Undoubtedly that is the natural evolution of the process, and obstruction does lead to perforative peritonitis which from time to time—and we could give examples—terminates the scene. But most frequently the patients do not die of peritonitis; they die from septic poisoning. It is the stercoræmia which kills, and which must be prevented.

Therefore, do not leave the patient, do not postpone till the morrow, do not take the terrible responsibility of waiting, or of losing time in the trial of any hopelessly inadequate procedures. I do not speak of purgatives: they are absolutely contraindicated; the patient whose history is given above, a young man 20 years of age, was killed by a purgative; it would be impossible to say how many others have received the *coup de grâce* from similar treatment, which were better described by another name. One may, if it is thought worth while, try two useful measures which will presently be described in detail—the electric enema and rectal injection—but if no result is obtained at the first trial, do not waste time in repeating a useless experiment, but prepare at once for operation.

The operation will be either **laparotomy** or **Nélaton's enterostomy**. The decision as to which shall be performed is often associated with considerable difficulty, and will depend: (1) *On the general condition of the patient and the duration of the obstruction;* and (2) *On the surrounding conditions.*

Laparotomy is the rational procedure, the method of choice; it is the operation which I should perform if called in early and the patient's condition was still satisfactory. I should also choose it even at a more advanced stage if I found myself under conditions which would permit of the operation being rapidly and properly performed. I may add—and my conviction is based on facts—that if there is sufficient determination the necessary conditions can be realized more often than one thinks.

It is none the less true that laparotomy for intestinal obstruction is a difficult and dangerous operation, which requires not only method and practice in abdominal surgery, but also skilled assistance. In that respect the difference between strangulated hernia and internal strangulation is

very great; a practitioner who has ordinary knowledge and initiative ought to be able to do a herniotomy; the same cannot be said with regard to operations for intestinal obstruction.

If alone, without proper assistance and also without sufficient operative experience, the practitioner will be well advised to refrain from undertaking a laparotomy: indeed the advice will be often almost superfluous. He must not, however, remain inactive, nor prolong the fruitless efforts to treat the condition by indirect methods; *he must perform enterostomy forthwith.*

Enterostomy is also the operation which must be performed when the patient's condition is very bad, when the obstruction is of comparatively long duration, and when the toxæmic symptoms are so pronounced that any operation or general anæsthesia lasting more than a few minutes must evidently be almost immediately fatal.

Though too often in the unrecognized or badly treated cases of obstruction we can do nothing more than open the intestine as speedily as possible, and with little hope of benefit, we must not forget the unexpected recoveries and paradoxical results which have from time to time been observed.

It is a grave matter for the surgeon to countersign, as it were, a death warrant by saying: It is too late, nothing more can be done, not even an enterostomy. A refusal to operate would only be justified in the presence of the signs of approaching death.

To sum up, *laparotomy is the method of election* in acute obstruction so long as the patient's vitality is sufficient to justify it; *enterostomy is almost always a method of necessity*, which has, however, because of its simplicity and safety, an undoubted value in a certain number of cases.

Unfortunately—and it is the great disadvantage of Nélaton's operation, and one which must always limit its field of usefulness—it is impossible to determine in advance what its value may be, and at the best there always remains one dark and uncertain feature in the case, namely, the nature of the obstruction. The intestine empties itself by the artificial opening, the distention disappears, the wall recovers some tonicity, the symptoms of septic absorption are relieved; so far good; but at the point of strangulation the intestinal lesions are progressing, uninfluenced by the operation, to terminate in gangrene, perforation, and diffuse peritoneal infection: *the patient escapes the dangers of toxæmia, to die of peritonitis.*

Such a termination is, however, far from being universal, and it would be wrong to exaggerate its frequency, as we might easily do if we considered intestinal obstruction simply as a mechanical condition.

Here, as in strangulated hernia, the factors are multiple; the muscular action of the intestinal wall, and the progressive distention of the segment situated above a primarily incomplete obstruction, play a considerable part in the evolution of the local lesions. There can be no doubt that the emptying of the upper segment of the bowel, in addition to checking septic absorption, also reacts on the area of actual obstruction, suspending and sometimes

arresting altogether the vascular stasis and the consecutive gangrene. One may add that this fortunate result is, other things being equal, the more likely to be obtained the earlier the operation is performed and the less the intestinal wall is damaged.

As a matter of fact, enterostomy may be followed by complete recovery; whatever the mechanism may be, at the end of some days the normal permeability of the alimentary canal is established. More frequently the grave symptoms of septic poisoning disappear, but the obstruction persists: and, at a later date, secondary laparotomy is required. Lastly, it may happen that, after a transitory improvement, a return of the vomiting with all the other usual symptoms indicates the onset of peritonitis, which usually runs a very rapid course and quickly terminates the scene.

To these possibilities we may add a fourth: that which occurs after *late enterostomies*, when the already too advanced septic intoxication pursues its course uninfluenced by the operation and ends fatally within a few hours. On several occasions we have seen patients, who had been brought to hospital on the third or fourth day of obstruction, die in this way after a quite simple enterostomy performed without general anæsthesia and followed by an enormous evacuation;[1] at the autopsy neither peritonitis or perforation was present; only a little bloody serum was found in the peritoneal cavity—nothing more.

A knowledge *of the situation and nature of the obstruction*, if it could be obtained beforehand by examination of the abdomen, would certainly be extremely helpful as a guide to immediate action, and also with regard to the prognosis. Still, in order to avoid mistakes, it will be well not to place too much reliance on the very interesting localizing signs to be obtained by percussion and palpation which have from time to time been recommended. They are not essential for the establishment of a definite diagnosis of acute obstruction, and that diagnosis, once made, is sufficient to determine the line of action. Further, these signs are only recognizable in the early stages of the illness; later, and at a very variable time, general meteorism masks any localized distentions.

With these reservations, it is none the less advisable to define, if possible, the nature of the primary lesion.

Therefore remember that the acute obstruction which we are now

[1] We wish, however, to emphasize the fact that, notwithstanding a subnormal temperature, a miserable pulse, and all the other signs which would seem to indicate the rapidly approaching end, it is impossible with certainty to foresee the issue, and the patient should never be denied the last chance which enterostomy provides. Under such circumstances recovery will sometimes be seen in cases which are to all appearance absolutely hopeless: of this I have had a recent and striking example, in the case of a woman on whom I operated *in extremis* on the sixth day of obstruction. No radial pulse could be felt, the extremities were cold and livid, the respiration feeble, and the abdomen enormously distended: it seemed certain that the slightest dose of ether or chloroform would have proved fatal in a few minutes. I contented myself therefore with superficial local anæsthesia by means of cocaine, and rapidly incising the right iliac fossa, seized the first presenting loop of small intestine, fixed it, and opened it. The opening was followed immediately by an enormous discharge of intestinal contents. The almost dying patient rallied well, the vomiting ceased, urine was passed, and the large injections of saline solution began to be effectual: next day the bowels moved spontaneously and naturally. As a practical rule, we ought to act as if it were never too late to operate.

considering, sudden in onset and complete from the beginning, corresponds to the following anatomical types :—

Acute intussusception.

Volvulus and the various torsions.

Strangulation by bands or diverticula.

Incarceration in intra-abdominal openings, natural or acquired.

Sudden impaction of a foreign body, particularly a gall-stone.

The patient's age and history may supply some preliminary indications. Intussusception is most common in young children ; the pre-existence of some acute abdominal affection, appendicitis, pelvic disease, or an operation scar, will cause one to think of strangulation by a band.

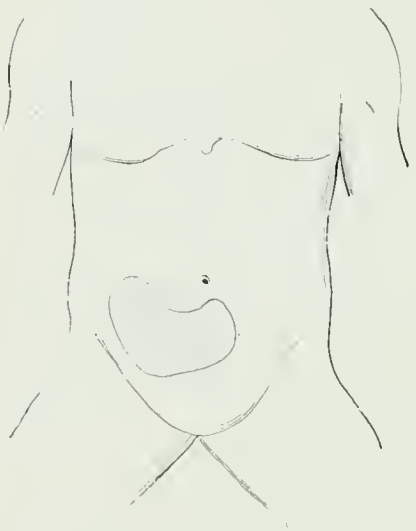

Fig. 375.—*Von Wahl's sign.* Diagrammatic representation of the results of abdominal palpation in a case of intestinal obstruction. Horse-shoe swelling, resistant, with definite outlines, situated in the right sub-umbilical region. The condition was a double intestinal knot shown in *Fig.* 385. (Zoege von Manteuffel, " Zur Diagnose und Therapie des Ileus." *Arch. f. klin. Chir.*, 1891, Bd. xli., p. 587, obs. 4.)

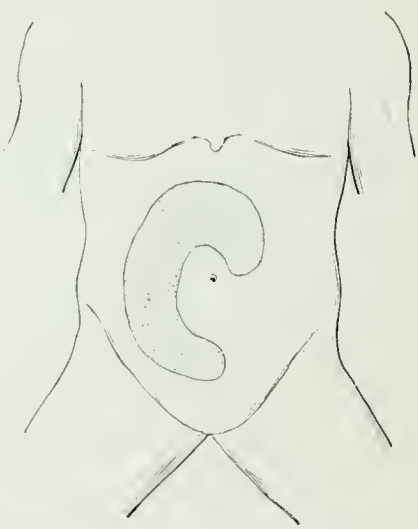

Fig. 376.—*Von Wahl's sign.* Diagrammatic representation of the results of abdominal palpation in a case of intestinal obstruction. Definite swelling, originating in the left iliac fossa, crossing above the symphysis, extending upwards on the right side of the abdomen and curving round above the umbilicus. Complex twist of the ascending colon. (Zoege von Manteuffel, *loc. cit.*, p. 598.)

Examine the cæcum ; if it is dilated and the right iliac fossa is filled with a resonant swelling which gurgles under the hand, the conclusion is that the obstruction is situated in the course of the large intestine ; if it is empty and the right iliac region is flaccid and depressible, then the obstacle occupies some part of the small intestine, and usually the meteorism is moderate and raises the abdominal wall in the form of a central rounded prominence, while the flanks and iliac fossæ are comparatively depressed. All this, however as before stated, can only be recognized in the initial stages and when the abdomen is sufficiently thin to lend itself to the examination.

Von Wahl's sign depends on this : The strangulated loop of gut above the obstruction becomes distended, paralyzed, and loses its mobility ; it

separates itself in a manner from the surrounding mass of intestines, and forms a species of tumour which can be detected by the sense of resistance it conveys on palpation and by the quality of the percussion note. The accompanying *Figs.* 375 and 376, from Zoege von Manteuffel's paper give an idea of the varied forms which these zones of initial distention may present.

Lastly, it is particularly in cases of intussusception that definite information may be obtained by an examination of the abdomen, a well defined, firm, cylindrical swelling being discovered. In addition, in cases of extensive intussusception, a rectal examination—essential in all forms of obstruction—may detect the apex of the invagination at some distance from the anus.

Chronic Obstruction.—It has been said with a good deal of truth that the uncertainty of the indications in cases of intestinal obstruction are very often due to the uncertainty of the diagnosis.[1]

Later on we shall return to the irregular forms of obstruction, clinically deceptive and not easily diagnosed; at present we shall consider characteristic chronic obstruction, in comparison with the typical acute from which we have just studied.

A man, about 50 years of age, was brought to hospital in great haste, with a diagnosis of internal strangulation. He had been seen during the day by several medical men, who had all agreed as to the urgent need for laparotomy. Everything had been prepared for immediate operation. The first impressions gained in examining the patient, however, did not indicate such a serious condition; he spoke easily, and in a clear voice; his face was pale, tired, ill-looking, but without that special appearance, or those signs of exhaustion, which are usually evident in cases of true ileus. The skin was warm; the pulse was rapid, it is true, but its quality was good. The bowels had not acted, nor had he passed flatus, since the preceding day: the abdomen was soft, a little distended, somewhat tender and tense in the iliac fossæ, but it did not convey to the examining hand that sensation of tense fullness which we mentioned when speaking of acute obstruction. Vomiting had been frequent in the early part of the day, but there had been none for some hours. When questioned, the patient stated that he was habitually constipated, and latterly more so even than usual, and that though his symptoms had acquired particular intensity since the day before, he had really been ill for several days.

[1] Here let us mention the splashing and dependent dullness studied by Mathieu, by which the existence of obstruction, and possibly its seat, may be recognized even when complete interruption of the fæcal current and abdominal distention are absent. By sudden percussion in the umbilical region loud splashing may be produced, similar to that which occurs in a greatly dilated stomach. When the patient is lying on the back this median zone is dull: in the lateral position the dullness shifts to the dependent side in the same way as the dullness of ascites. Similar phenomena have been observed in cases of incomplete or slow obstruction: they indicate an obstacle situated low down in the small intestine. (Mathieu, "Le clapotage et la matité déclive dans l'occlusion incomplète de l'intestin." *Soc. méd. des hôpitaux*, 22 mai, 1908. Ricard. "Note sur un signe d'occlusion intestinale de la partie inférieurs de l'intestin grêle." *Soc. de chir.*, 14 juin, 1907, p. 685, and also, "Sur un signe de diagnostic du siège de l'occlusion intestinale." *Ibid.*, 11 mars, 1908, p. 330.)

The idea of operation was therefore given up, and an electrical enema was administered in the manner we shall presently describe. The intestinal contractions were well marked; the salt solution injected into the rectum was repeatedly expelled; at the end of twenty minutes there was undoubted passage of flatus, accompanied with a small quantity of liquid fæces. The diagnosis of fæcal obstruction was therefore confirmed. The electric treatment was discontinued. Two hours later the patient had a large motion, followed during the night by a dozen more.

Such cases are not uncommon. They are characterized by introductory symptoms of varying duration; by obstinate constipation, with occasional attacks of diarrhœa, irregular abdominal pains, and some distention; by the obstruction being incomplete, some flatus and liquid matter being passed, at least during the first days of the illness; by the rarity of fæcal vomiting, notwithstanding the comparatively long duration of the serious symptoms; and by the mildness of the general phenomena, which never indicate that profound intoxication so characteristic of acute stercoræmia.

The obstruction may manifest itself by an acute onset, and it may also, after some days, become associated with the grave symptoms of true ileus; however, there is always some feature wanting or effaced in the picture, and the protracted progressive course of the initial symptoms, and the premonitory attacks of incomplete obstruction, will usually, if properly analysed, render a correct diagnosis possible.

Lastly, on palpation of the abdomen, the doughy fullness in the lateral regions along the track of the colon, especially when localized, the nodular, thick masses of varying hardness and density which are found in one or other iliac fossa, in the cæcum or sigmoid colon, sometimes the fæcal plugging of the rectum discovered on digital exploration, will confirm the diagnosis. However, even in the most characteristic case of **fæcal obstruction**, distrust purgatives, and above all, do not delay, but have recourse at once to the two excellent methods of treatment which we shall study immediately: the *electrical enema* and *irrigation of the colon*. When properly employed, the former is the best therapeutic agent in cases of this kind. In obstinate and severe cases, when all attempts have failed and when the symptoms of septic intoxication are becomnig urgent, enterostomy remains as a valuable resource; this is usually followed shortly after by a profuse fæcal discharge from the anus, indicating a restoration of the intestinal contractility.

In general terms it may truly be said that the best way of restoring the tonicity and functional powers of the intestine is by putting an end to the stasis of its contents and relieving the distention of the segment above the block.

In the other types of chronic obstruction, due to **narrowing of the intestinal calibre by a new growth**[1] or to **compression by a tumour**,

[1] It must not be forgotten that acute, sudden, and unexpected obstruction may arise in the evolution of an intestinal growth which had previously given no indications of its presence. For instance: a man about 60 years of age was brought to the Municipal Nursing Home in a most serious condition, with symptoms of complete obstruction of two days' duration, fæcal

in the pelvis or mesentery for instance, or to chronic intussusception, the surgeon's action will naturally vary according to the circumstances.

Case 25.—A woman, 70 years of age (I am quoting one of my own cases), extremely cachectic and greatly emaciated, had been ill for a fortnight with obstinate constipation, abdominal pains, and vomiting. Just before I saw her she had had a large fæcal vomit; the abdomen was uniformly tense and distended. No tumour could be detected either by external palpation or digital examination of the rectum; the tongue was dry and the general condition very bad. There could be no doubt as to the proper course to pursue; it was necessary to open the bowel as speedily as possible. An incision was made in the left iliac fossa, and as soon as the finger was introduced into the abdomen it encountered a hard, nodular, adherent tumour involving the sigmoid colon. A colostomy was performed on the bowel above the site of obstruction.

At other times the neoplasm may be detected before the operation, and its anatomical characters will be in keeping with the patient's history and the failure in the general health.

In the great majority of these cases the only treatment consists in the immediate formation of an artificial anus, which must usually be permanent. Even when the tumour is freely movable and definitely circumscribed, or when there is reason for doubting its malignancy, the time would be badly chosen—with the patient in a condition of septic poisoning—for performing any radical operation; it is much better simply to limit immediate action to opening the gut and relieving the obstruction, leaving the questions of enterectomy or entero-anastomosis to be settled at a later date, when the crisis is past and an adequate examination can be more easily and satisfactorily made. Later on we shall see what treatment should be adopted when an intestinal new growth is met with during the course of a laparotomy.

The situation is different when it is evident that the symptoms are due to the pressure exercised on the bowel by an external tumour such as a uterine fibroid, an extra-uterine pregnancy, a pelvic hæmatocele, an incarcerated ovarian cyst, a mesenteric tumour, etc. In such cases the obstruction may be due to a double factor: the direct pressure of the increasing mass, and to angulation of the stretched and adherent intestine.

The proper treatment will often be to attack the cause of compression directly by opening the abdomen and proceeding at once to the extirpation of the tumour, the evacuation of the accumulation, or the separation of adhesions, or whatever may be necessary; enterostomy being reserved for bad cases where the delay has been too long and the toxæmia is too far advanced, or where the surroundings permit of nothing else. For instance:

Case 26.—A young man, 20 years of age, a deaf-mute, was brought to me suffering from obscure symptoms of obstruction; they were of several days' duration, and the attack was only a repetition of several similar ones which had

vomiting, considerable abdominal distention, and wretched pulse. The attack had developed suddenly without any previous warning symptoms, and had at once assumed very threatening characters. On opening the abdomen a large cancerous mass was found in the terminal part of the small intestine; enterostomy was performed above the seat of the obstruction, with only very temporary relief.

occurred on previous occasions. The constipation had been complete, at least so far as solid or fluid matter was concerned, for two days, but some flatus was still being passed; the vomiting had no particular character; the abdomen was distended, tender in the right iliac and subumbilical regions, and within the limits of these regions, about three inches above the pubic symphysis, an indefinite, rounded, tense tumour could be felt. It was difficult to determine the exact nature of the swelling, as a satisfactory examination was prevented by the abdominal distention. However, as the symptoms had become worse during the day, the discovery of the swelling indicated quite definitely the course to be adopted. I opened the abdomen and found a hydatid cyst of the mesentery, the size of the two fists, which, after having been emptied, was carefully enucleated; the compressed intestine recovered its normal calibre at once, and next day the bowels moved naturally.

To sum up, laparotomy is rarely indicated as an urgent necessity in typical chronic obstruction. **Electrical enemata** and **irrigation of the colon** should usually be tried in the first place, and are sufficient in a large number of cases; if they fail, an **enterostomy** or permanent **artificial anus** will probably be necessary.

Pseudo-obstruction.—Hitherto we have been considering definite clinical situations, or at least situations sufficiently definite to provide the medical attendant with all the data necessary for a correct diagnosis and rational treatment, particularly if he realizes the fundamental importance of the axiom that the symptoms of intestinal obstruction, even in their most chronic form, are always serious and require immediate treatment. The statement is equally applicable, no matter what the anomalies in the clinical picture may be, to the *pseudo-obstructions* and the *paralytic obstructions* of which we now propose to speak.

Case 27.—A man, 39 years of age, was brought to the Municipal Nursing Home in a very serious condition. For forty-eight hours there had been no movement of the bowels, nor had flatus been passed; the vomit had become fœtid and blackish, the abdomen was considerably distended, particularly in the supra-umbilical zone; the pains were intense, the face was pinched, the pulse very fast and very small. There were indeed all the signs of a grave form of acute obstruction. Such as a matter of fact was my diagnosis, and having made up my mind not to quit the patient until I had in one way or another relieved the obstruction, I began by trying electric enemata. Some painful contractions of the lower bowel were the only result.

There was evidently no time to lose. I therefore opened the abdomen in the middle line above the umbilicus where the distention was most marked, and a hugely dilated transverse colon at once escaped from the wound. It was retained outside under an aseptic compress, to leave room for an exploration of the rest of the abdomen. The descending and sigmoid colons were equally distended; *there was no trace of band, tumour, angulation, or any obstacle whatever*; the great gut was uniformly distended and atonic in its whole length. What was to be done? To simply close the abdomen seemed dangerous. I therefore performed a small enterostomy on the transverse colon; the intestine had scarcely been fixed to the wall and incised when an enormous quantity of gas escaped noisily from the opening, mixed with some yellowish liquid fæces. The rest of the abdominal incision was closed. At the end of a few days the bowels began to act naturally, the patient recovered perfectly, and two months later I closed the fæcal fistula without difficulty.

Case 28.—A woman, 40 years of age, was sent to me from the medical side with fæcal vomiting, the abdomen greatly and uniformly distended, a bad pulse, and all the appearance of advanced toxæmia. Laparotomy was performed forthwith. I found the intestines a little reddened, and a small quantity of serous fluid in the abdomen, but here again, no sign whatever of any mechanical obstruction. A loop of small intestine was brought out through the wound, and secured by a rod passed through its mesentery, the rest of the wound being closed. I performed in fact the first step in the formation of an artificial anus (see later), with the intention of completing the operation if there was no improvement in the condition. However, the same evening the bowels began to move spontaneously and profuse diarrhœa ensued, the stools being purely liquid, without any hard or solid material, similar to those which are passed after the relief of a mechanical obstruction.

Further examples are scarcely required, still I wish to relate another.

Case 29.—A post-office clerk, 35 years of age, began to suffer with pain in the abdomen on the 15th January, 1898; on the 19th he was admitted to hospital under the care of M. Debove. His face was pale and anxious and somewhat pinched, the pulse was rapid and rather small, the tongue yellowish-white; during the previous day and night there had been some sickness and vomiting; the vomit had no particular character. The bowels had not moved for several days, but flatus had been passed. The abdomen was large, particularly in the supra-umbilical region, of a uniformly doughy consistence, without any induration or prominence at any point. An electric enema was administered without result. The next day the condition was practically unchanged; there was very little vomiting, and the vomited matter consisted simply of bile-stained fluid; the abdominal distention was no worse. Another electric enema was tried, without success. During the night the condition became much worse, and next morning I was shown a whole wash-basin full of definitely fæculent material which had been vomited. Laparotomy was performed forthwith, and, I may add, with regret at having delayed operation for forty-eight hours. As soon as the peritoneum was opened, a small quantity of clear serous fluid escaped, and I came down upon thickened, very fatty omentum, covered with hard, rounded, yellowish nodules, each about the size of a millet seed, quite evidently tuberculous granulations. These tubercles were dispersed throughout the whole thickness of the omentum and over all the surface of the intestines. Further exploration of the abdominal cavity failed to discover any constricting band or area of adhesions, or any collapsed segment of intestines; the sigmoid colon was distended equally with the first part of the small intestine. There was no mechanical obstruction. The abdomen was closed. In the evening the bowels moved spontaneously, and a large liquid motion gave evidence of the abrupt cessation of the paralytic obstruction.[1]

Functional disturbances of the intestinal musculature, either in the form of paralysis or of segmental spasmodic contracture, can alone explain satisfactorily cases of this kind, which are perfectly authenticated and complete, since they have been verified by direct observation during the course of operations.

Whatever the pathogeny may be, we must in practice reason as follows:

1. **These paralytic obstructions, pseudo-obstructions, or obstructions without any mechanical cause,** are very serious condi-

[1] *Société de chirurgie*, 1898; and also, Guillemare, *Les formes aiguës de la péritonite tuberculeuse*. Thèse de doct., 1898, No. 340.

tions ;[1] even though due to atony of the intestinal wall, the stasis of the intestinal contents is followed by stercoræmia, and death may result.

I have had undeniable proof of this in the case of a patient, a man aged 56 years, who had been admitted to hospital with a broken thigh, and who was suddenly taken ill two days later with all the signs of acute obstruction. Electric enemata were tried without success ; enterostomy was performed, but gave vent to only a very small quantity of gas and fæcal fluid, and the patient died on the third day. At the autopsy, carefully performed, no obstacle whatever to the passage of the intestinal contents could be discovered ; intestinal paralysis was the sole cause.

2. We can have beforehand **no certainty as to the nature and pathogeny of the obstruction** ; we can presume the existence of this or that form of ileus, but we can see only the symptoms, and it is from those symptoms, properly interpreted, we must draw our conclusions. However, with paralytic obstructions, although the appearances are often those of acute obstruction, there are not seldom indications in the evolution, mode of onset, antecedents, and in the general condition, which are not in keeping with the typical form. One must therefore recognize the necessity for giving electrical enemata a fair trial before proceeding to other measures.

It is in cases of pseudo-obstruction that electrical treatment finds its most valuable application ; I mean, of course, when properly employed and not prolonged beyond reasonable limits. If it fails after two or three trials, and the general symptoms are advancing, laparotomy should be performed.

It is well to know of the existence of these anomalous forms of obstruction ; they are very deceptive, and after the abdomen has been opened and " nothing found," very grave doubts may remain in the mind of the operator lest he may have overlooked some mechanical cause of obstruction.

The simple opening of the abdomen, perhaps the " exposure to the air " and the handling of the intestinal loops, may suffice to awaken the contractility of their walls ; in several cases a spontaneous movement of the bowels a variable number of hours after operation has been recorded.

[1] It is advisable to mention here the conditions due to embolism of the mesenteric arteries or to thrombosis of the mesenteric veins, conditions which have very often a close clinical resemblance to obstruction, and have been the cause of a certain number of emergency operations. The onset is usually very sudden, and from the first the pains are exceedingly severe : they are situated chiefly in the epigastric region and round the umbilicus, and to the end they remain continuous and abnormally acute ; the abdomen becomes rapidly distended ; fæcal vomiting may supervene and may be combined with complete arrest of fæcal evacuation. It is to be noted, however, that the passage of considerable quantities of blood by the bowel is frequently observed in the early stages of the illness. It is necessary to know of the existence of this rare and terrible affection, though without any illusions as to the possibility of making a certain diagnosis nor as to the results of laparotomy, which may, however, be quite justifiably performed if any doubt exists as to the nature of the condition. Similar symptoms of pseudo-obstruction may occur in cases of hæmorrhagic pancreatitis, and may run quite a similar course : on opening the abdomen one usually finds the omentum and mesentery strewn with small greyish-yellow nodules which represent so many islets of fat necrosis. Laparotomy, with simple evacuation of the hæmorrhagic effusion, and drainage, has sometimes been attended with satisfactory results.

Still, to us it seems inadvisable to simply close the abdomen without doing anything further in these cases, and particularly as a negative exploration must always leave a very reasonable doubt in the surgeon's mind. To fix a small loop of gut in the wound, holding it in reserve for the purpose of performing a subsequent enterostomy, constitutes a very simple procedure, which has on several occasions been attended with successful results. When there is considerable intestinal distention, and the symptoms are urgent, it is always the safest practice to make at once a small enterostomy for the purpose of drainage, which, by relieving the overstretched intestinal wall, will give it a better chance of recovering its lost contractile power.

In conclusion, the following are the available therapeutic measures in the various forms of intestinal obstruction: (I) *Irrigation of the colon:* (II) *Electrical enemata;* (III) *Laparotomy*, followed by the manœuvres necessary for exposing and removing the obstacle; (IV) *Enterostomy* (fæcal fistula) or *artificial anus*.

When properly used, colon irrigation and electrical enemata will be successful in the cases of fæcal obstruction, of paralytic ileus, and in the initial phases of some other forms: they constitute indeed, and deservedly so as preliminary measures, the routine methods of treatment. They only become dangerous when improperly used; and when too long and ineffectually employed they entail the loss of valuable time.

I.—IRRIGATION OF THE COLON.

This consists in injecting under moderate pressure variable quantities of tepid aseptic fluid by the rectum, as high up as possible into the bowel.

Irrigation of the colon properly carried out is a safe and valuable means of treatment; the same cannot be said of forcible injections by the anus: the sudden and forcible propulsion of a considerable volume of fluid into the large intestine—particularly in cases of obstruction—involves the risk of rupture. This danger is by no means theoretical, for the accident has occurred several times; and further, overstretching and irritating the intestinal wall produces the worst possible conditions for obtaining the desired result. The injection ought to be administered *slowly* and *steadily*; only under these conditions can it be copious without becoming dangerous. Further, the efficacy of the method depends on the quantity of fluid injected, and on its penetration to a high level in the intestine.

Place the patient on his back across the bed, in the lithotomy position, with the lower limbs well wrapped up and comfortably supported, the pelvis moderately elevated by a pillow or a folded sheet, the left hip a little higher than the other, and the body somewhat inclined to the right.

For the injection will be required:—

1. **A large rubber tube,** 10 to 12 inches long at least (a stomach tube answers the purpose perfectly, or an œsophageal tube will do). If the patient is a child, a soft rubber catheter, about No. 15 English for instance, is quite

satisfactory; for an adult it may also be used if there is nothing else; but usually it is inadequate. With a short tube of small calibre considerable difficulty will be experienced in getting the fluid to pass beyond the lower part of the rectum, and as we have already said, an essential feature of the method consists in getting the fluid to as high a level as possible. The tube, whatever it may be, should be boiled, and freely lubricated with sterile vaseline before introduction.

2. **A douche-can**, with a capacity of 1 to 2 quarts, fitted with a rubber tube; a funnel, or any other injection apparatus acting by gravity, will serve the purpose.

3. **Some boiled water** at a temperature of 99° to 100°.

The nature of the fluid is comparatively a matter of indifference; it produces its action by its bulk, not by its quality: the sole conditions that it must fulfil are to be non-irritating to the intestinal mucosa and to be harmless if absorbed. Tepid boiled water meets these requirements best and most simply. Olive oil is also an excellent injection fluid, and is easily procured.

Now smear the anal region freely with vaseline, and proceed to introduce the tube. Carry it first of all on the index finger into the rectal canal, then continue the introduction very gently, little by little, always gripping the tube close to the anus, and shifting the fingers as it slips in; push it first of all directly backwards, then incline it a little to the left and forwards; above all, do nothing roughly, but let the tube be guided by the channel which will open before it under gentle pressure; if any resistance is met with, draw the tube back a little and feel for the channel, directing the tube to the side, or backwards or forwards, or by turning it a little or communicating a gentle screwing movement to it. Usually the chief obstacle is situated at the recto-sigmoid junction, where the sharp bend in the gut and a prominent fold of the mucous membrane impede the onward movement. Force is useless; the instrument must be insinuated past the obstacle just as in passing a catheter.

In this way one may succeed in making the tube penetrate to a considerable depth, from 8 to 12 ins. or more, up to even 20 ins.; no other rule can be given than this: introduce the tube as far as it can be persuaded to go without forcing.

Now connect the tube of the douche-can or funnel with the outer end of the rectal tube, and raise the reservoir to a sufficient height to cause the fluid to flow into the intestine at moderate pressure. In practice, the elevation should not be more than 30 or 32 ins. above the horizontal plane of the patient, and this level should only be gradually reached; begin by raising the reservoir to a height of 12 or 16 ins., and if the level of the fluid sinks regularly, and the patient feels no pain, then gradually increase the pressure. By this slow method a much deeper penetration of the fluid is obtained, and it can be injected in greater quantity without danger.

What quantity should be injected? With the reservations just formulated, it may without risk amount to several pints (4 pints in a child, 8 to 10 in the adult), but it is impossible to speak definitely. The largest

quantity of fluid possible under low pressure will be injected.[1] It is advisable, particularly at the beginning of the injection and in cases where it has not been possible to introduce the tube very far, to compress the anus with the fingers, and thus prevent the escape of the fluid.

After completing the injection the tube will be rapidly withdrawn, and the patient returned to bed and kept quietly in the horizontal position. The injection is returned more or less quickly, often with considerable colicky pains; if the result has been negative, the returned fluid is clear, or at most coloured by the washings of the lower bowel; if successful, it will be accompanied by the passage of flatus and some hardened fæcal masses.

In successful cases a satisfactory movement of the bowels does not always come about at once, even when the emission of flatus has indicated the relief of the obstruction, but it occurs after some hours.

It is particularly in the cases of *fæcal obstruction* that these large and high injections are useful, and also in *the early phases of intussusception*, especially in children. As a matter of fact it is known[2] that fluid introduced in this manner, if in sufficient quantity,[3] may force Bauhin's valve (the ileo-cæcal valve) and gain admission to the small intestine; but, as has been demonstrated by Dauriac and Lesage, the condition necessary even for such deep penetration[4] is slow steady injection under low pressure.[5]

II.—THE ELECTRICAL ENEMA.

The application of the electrical enema is much less general than that of colon irrigation, for the simple reason that it requires special apparatus. If a good galvanic battery is not available do not waste time in making the muscles of the abdominal wall contract with a little faradic machine; possibly in some not very obstinate forms of fæcal obstruction, as an adjuvant to large irrigations, *this electric massage* of the abdominal wall—and through it of the intestine—may be of some value: in serious cases nothing will be gained by it.

The doubts and misconceptions which sometimes obtain regarding the

[1] The level to which the fluid is passing in the large intestine should be determined by percussion and succussion.

[2] See the discussion of the question in Henri Angerant's thesis. *Les grands lavages de l'intestin. Etude historique, critique et expérimentale.* Paris. 1894. No. 378.

[3] According to Lesage and Dauriac, in order that the fluid may penetrate in fair quantity into the small intestine, it is necessary to inject by the rectum about 2 pints in the case of a young infant, 4 pints in the child, and about 14 in the adult: naturally the figures are approximate only. (Dauriac et Lesage. "Des grands lavages de l'intestin grêle." *Gazette des hôpitaux*, 17 oct. 1897.)

[4] As fæcal obstruction most usually occupies one of the segments of the large intestine, there would of course be no question of reaching or forcing the ileo-cæcal valve in such cases.

[5] We have not spoken of the injection of aerated water: the famous irrigation with Seltzer water we do not believe has the least special value: when one or several syphons are emptied through the rectal tube it is simply a case of utilizing the pressure of the gas as the agent to cause the penetration of the fluid, and for that reason the procedure might possibly be of some value in a case of urgency. The insufflation of air into the rectum is either illusory or dangerous.

real value and efficacy of electrical treatment in cases of intestinal obstruction are greatly due to misuse of the method, either by employing it badly, or by failing to recognize its proper indications.

In some of the **chronic obstructions, and in paralytic ileus** particularly, the electrical method of treatment is excellent if used with a proper technique, and if the operator knows when to abandon it. I saw it employed by Boudet, of Paris, and was struck with the results which he obtained; since then I have myself employed it on many occasions and have had many successful cases.

A good galvanic battery is needed, able to give a current of 50 milliampères. I might add that the battery must be in thorough working order and its management properly understood. The two conducting wires are connected, one to a large metal plate covered with chamois leather, which will be moistened with salt solution, and applied, in the manner we shall immediately describe, to the anterior abdominal wall; the other, to the rectal electrode, which consists of a gum-elastic tube with an eye at its extremity and containing a central metallic rod to which the wire is joined; the tube itself is placed in communication by a lateral branch with the indiarubber tube of a douche apparatus.

With the patient lying on his back, having the thighs well flexed and separated, begin by introducing the rectal electrode as high up as possible, in the manner previously described. Then connect it with the wire corresponding to the positive pole of the battery. Well moisten the abdominal plate and join it to the negative wire, then apply it to the abdomen, over the left flank for example. Take care to change the position of this negative electrode every four or five minutes, placing it successively on one and the other iliac fossa, on the right flank, the umbilical region, etc. Before turning on the current the rectum must be filled with fluid.

Tepid salt solution is the agent used; it must be injected very slowly by elevating the reservoir gradually and only half opening the tap. In this way from one to two pints will be introduced according to the tolerance of the rectum; then the reservoir will be placed at such a height that the fluid will run continuously into the bowel under very low pressure during the whole of the procedure.

The salt solution protects the mucous lining of the intestine by isolating it from direct contact with the electrode, and at the same time diffuses the electric current, acting somewhat as a *large liquid electrode*.

The time has now come to **administer the current.** The strength may vary from 10 to 50 milliampères; it must not be given in full strength at once, but gradually increased. The methods of gradation vary with different machines, and it is therefore desirable that the operator should be familiar with his apparatus, and thus able to judge approximately the number of divisions to be employed. Begin with the lower strengths, to test the sensibility of the patient; if nothing abnormal supervenes, and if the current is well borne, increase the strength fairly quickly up to 35 or 40 milliampères.

The patient's sensations are of little value as a guide to the strength of the current ; at the end of some minutes he will feel a smarting at the position of the abdominal electrode, and at the moment when the current is suddenly varied, when it is increased or reversed, a more or less sharp pain will be experienced : the painful intestinal contractions, the cramps, the colic, and the desire to defæcate will not appear until a little later. Every five or six minutes it is advisable to reverse the current by moving the commutator from one side to the other ; to avoid a violent contraction the current must be shut off before being reversed, and, once the change has been made, rapidly increased to its former strength.

The desire to defæcate becomes as a rule increasingly intense and painful as the electrization is prolonged ; in thin-walled abdomens the intestinal contractions are sometimes evident under the walls ; quite often the saline fluid is abruptly expelled from the rectum, and with it the electrode if care is not taken to hold it in position. The current must then be stopped for a few minutes while a fresh quantity of salt solution is injected.

When the treatment is primarily successful, this expulsion of the salt solution is sometimes accompanied by the audible emission of flatus, perhaps several times repeated, which is always a good augury, as at the same time it confirms the diagnosis and constitutes an assurance of recovery. The treatment is continued, and not uncommonly terminates by the evacuation of a certain quantity of thick liquid fæces, sometimes by an enormous evacuation. The quantity of fæcal matter expelled is in some cases almost past belief ; on several occasions I have seen the stream of fæces inundate the bed, the floor, and the surgeon himself.

Do not anticipate, however, such an immediate complete emptying of the bowels : continue the treatment for a quarter of an hour or twenty minutes if the patient is not too much exhausted ; if some fæcal matter has been passed, and there has been undoubted emission of flatus, the treatment may be stopped, with confidence that the difficulty has been overcome, and that the result will be completed spontaneously, or with the aid of very simple means, within a few hours.

If no result has been obtained it will still be advisable to discontinue the treatment at the end of the time mentioned, and then, to my mind, comes a very difficult question, involving grave responsibility, the answer to which, if given without due consideration and based on certain fixed ideas, may convert this valuable method into a dangerous one. The question is : In view of the first check shall we defer the next attempt for seven or eight hours, and if we fail then, wait for a further similar lapse of time ?

It must be borne in mind that when treating a case of obstruction we can never be quite clear as to the nature of the lesion ; at any rate, it is a wise practical rule only to accord a limited credence to the diagnosis of the nature of the obstruction. We must be guided chiefly by the general condition of the patient and the character of the symptoms.

If the abdomen is not much distended, if vomiting is not frequent, if the pulse and facies are good ; if there is *a strong probability that the condition*

is one of fæcal obstruction, or good reason for suspecting pseudo-ileus, we may allow the patient to rest for a few hours, while keeping him under supervision, and if the obstruction persists we must make a second attempt without waiting for half a day; as a general rule it can be borne at the end of two or three hours. The attempts may be thus several times repeated, and finally give a successful result; but such a line of treatment is only applicable to the chronic or paralytic forms of obstruction, and in them alone is it justifiable.

In the presence of acute severe symptoms, if it is considered worth while giving even a first trial to electrical measures, failure should be considered as a confirmation of the diagnosis and as indicating the need for immediate operation.

III.—LAPAROTOMY IN INTESTINAL OBSTRUCTION.

It must be recognized that laparotomy is always a serious and difficult operation; but the earlier the stage at which it is undertaken, the shorter is its duration, the simpler the technique, and the less grave will it be. Commonly, when opening the abdomen we do not know what will be found, we do not even know if an obstruction will be discovered: we may be compelled to perform an intestinal resection or an entero-anastomosis: we must be prepared to deal with any condition which may be encountered.

Before beginning the operation, do everything possible to protect the patient from shock, and to avoid loss of time: take care that the operating-room is well warmed, wrap the patient's limbs and chest in cotton-wool and flannel, and inject a pint of saline solution under the skin before commencing the anæsthesia, which must be in the charge of a careful assistant.

Preliminary lavage of the stomach is an excellent precaution; it is, indeed, essential when the vomiting is profuse and already fæculent: otherwise, the patient will be exposed to the risk of sudden death from asphyxia during the operation, from the entry of vomited matter into the larynx. Numerous calamities have demonstrated that this is not a theoretical danger: the accident has happened to ourselves, in the case of a patient who was in a very collapsed condition: the anæsthesia was almost complete when there was a sudden fæcal regurgitation which filled the mouth and escaped from between the lips; respiration ceased at once, and notwithstanding all our efforts and the immediate performance of tracheotomy, we failed to resuscitate the patient.

The abdomen will always be opened in the middle line below the umbilicus, whatever may be the supposed seat of the obstruction. The incision will extend from the umbilicus to the pubes, and will subsequently be enlarged if necessary; the opening of the peritoneum must be very cautiously executed through a fold raised with the dissecting forceps, for there is considerable risk of injuring the distended bowel unless great care is exercised.

The actual operation consists of two chief steps: (1) *The search for the obstruction*; (2) *The restoration of the permeability of the intestine.*

1. The Search for the Obstruction.

As soon as the abdomen is opened some intestinal loops escape from the wound and are retained under guarded[1] compresses: possibly this partial and involuntary evisceration will disclose the obstacle; but this cannot be relied upon.

Be that as it may, before undertaking any other manœuvre, a preliminary manual exploration of the abdomen is useful when the external examination has detected beforehand some definite pathological condition, such as a tumour, an intussusception, or a dilated immobile loop. Raise the abdominal wall and slip the fingers gently under it in the direction of the lesion, while an assistant retains the extra-abdominal mass of intestine under a compress: carefully and rapidly performed, this preliminary search sometimes succeeds in cases of intussusception or obstruction by a tumour or volvulus. If nothing is at once discovered, do not prolong the search blindly; displace the mass of intestines to the left, and **look for the cæcum** in the right iliac fossa.

When there is considerable distention this manœuvre is often very difficult: it will be quite illusory unless the assistant knows how to keep the intestines under his fingers and out of the operator's way. *The cæcum must be seen; it is not sufficient merely to feel it.*

If it is collapsed and empty, the obstruction must be situated higher up in the small intestine, and will be reached by following the ileum and jejunum from below upwards. *If the cæcum is distended*, the blockage occupies the large gut: follow the ascending and transverse colon; if they are also dilated, turn the small intestines to the right, and examine the descending colon and the sigmoid.

These manœuvres can only be executed satisfactorily when the distention is not excessive. Otherwise one must have recourse—if nothing better can be done, as we shall see presently—to a systematic intra-abdominal examination in the manner described when speaking of Wounds of the Intestine: the first presenting loop of dilated small intestine is taken as the point of departure; it is secured by the hand of an assistant, or by a thread passed through the mesentery, and then the exploration is carried out upwards and downwards from the starting-point, segment after segment of gut being extracted, examined, and returned.

This is certainly a slow and troublesome method, and not so good as primary total evisceration; but when the assistance is inadequate, or the patient is in bad condition, and when it is carried out patiently and systematically, it is still a valuable resource.

Total evisceration consists in making primarily a long incision from the lower end of the sternum down to the pubis, turning the whole mass of intestines out of the abdomen, and covering them up at once with warm

[1] It is a rule without exception, particularly in these hurried laparotomies: no compress or swab must be allowed to remain in the operation field unless secured by forceps.

moist aseptic towels. In this way the area of obstruction is opened to view, and the investigation is limited to a simple detailed verification of the nature of the lesions. Before proceeding to deal with the obstruction, all the intestines are replaced in the abdomen with the exception of the affected segment, which is retained outside.

The reposition is often an exceedingly difficult matter: the best plan is to envelop the whole mass with a large compress, which is slipped on either side under the edges of the abdominal incision; then the operator, with hands widely spread out over the surface of the compress, insinuates the mass back into the abdominal cavity, the assistant helping by lifting up the edges of the wall. A useful device, recommended by Roux, consists in passing a stout thread through each lip of the abdominal wall, which greatly facilitates the assistant's part of the work (*Fig. 377*).

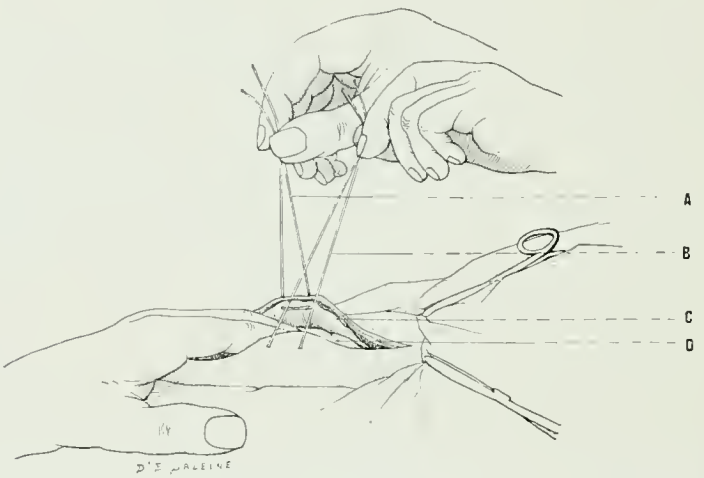

Fig. 377.—Reposition of the intestinal mass in the abdomen. Each of the lips of the abdominal incision is lifted up by a loop of stout thread. (A, B) The two traction threads. (C) The anterior parietal peritoneum (D) Compress spread out over the surface of the intestines.

When the intestinal distention is very great, the best and most expeditious plan is **to empty the intestine by a short incision** made on the free border of a dependent loop, which must be carefully isolated by gauze folds before being opened. Multiple capillary punctures are much less efficacious and more dangerous than this free incision, which, after having served its purpose, will be sutured in two layers like any other intestinal wound.

Apart altogether from its usefulness in facilitating the reposition of eviscerated intestines, this **drainage enterotomy** may be of great assistance in cases where, when the abdomen is opened, intestinal coils are met with so enormously distended as to offer a serious hindrance to any intra-abdominal exploration.

In some forms of obstruction, the cases of volvulus, or of extensive torsions involving the whole mass of the small intestine, total evisceration

is absolutely necessary; in all cases it constitutes a rapid and efficient method of exploration if it can be done without too much risk. But it provokes a more or less considerable degree of shock,[1] and to be beneficially employed it requires skilled assistance and a measure of cool determination.

2. The Restoration of the Permeability of the Intestine.

This is the second step of the operation, and includes a series of more or less complex procedures, according to the type of obstruction and the character of the lesions discovered.

(*A*). **Bands and Rings.**—That type of obstruction which it is customary to describe as strangulation by bands includes several different anatomical varieties, of which the principal ones may with advantage be defined.

A band, when it is fixed at its two extremities and stretches like a bridge from the anterior or posterior abdominal wall to the mesentery, or one of the mesocolons, or one of the viscera, or again from one segment of the intestine to another, may be an agent in causing constriction, or acute angulation or torsion.

Constriction reproduces conditions absolutely identical with those which occur in strangulated hernia: under the constricting band, which is of variable thickness and strength, being sometimes as thick as a pencil or the little finger, and which corresponds to the neck of the hernial sac, the two ends of the loop are found, constricted, and sometimes in a condition threatening gangrene and perforation, and beyond it the middle portion of the loop, dilated, tense, immobile, and blackish; perhaps, if the condition is of some duration, mottled with small gangrenous plaques.

Practically one proceeds exactly as when dealing with a strangulated hernia: the band will *be divided* carefully on the finger, if it can be slipped underneath, or on a grooved director, or perhaps *one of its fixed extremities may be detached*; or, again, if it is thick, short, and intimately connected with the underlying intestinal wall, it may be *incised directly* and carefully, layer by layer, until finally it allows itself to be broken easily by the pressure of a finger. Now examine closely the whole length of the loop, and particularly the circumference of the constricted portion, cleanse it carefully with warm boiled water, and take note of its condition.[2] If this is satisfactory, the loop, before being replaced in the abdomen, should be emptied, the

[1] See a good study of evisceration in the thesis of Louis Tixier, *Pratique de l'éviscération en chirurgie abdominale. Du shock abdominal. Etude clinique et expérimentale.* Thèse de doct. de Lyon, 1897.

[2] The examination ought also to be carefully extended along the upper limb for a sufficient distance from the seat of constriction. As a matter of fact, after prolonged occlusion, lesions of the upper end, sometimes of considerable extent, are by no means uncommon: erosions of the mucous membrane, superficial ulcerations (Kocher's "ulcers from distention"), progressive ulcerations which, eating slowly through the wall of the intestine, are the cause of many perforations. Such lesions constitute the starting-point of some of the late and fatal complications of operation. We shall have to refer to similar conditions when discussing strangulated hernia (see Strangulated Hernia).

contents being made to pass by gentle pressure into the lower intestinal segment. This precaution should always be observed after the relief of any internal strangulation.

More frequently, however, a band produces **acute angulation** of the intestinal tube, which, being fixed or suspended at one point, becomes acutely flexed and folded on itself, and thus as absolutely impermeable as under the circular compression of a ring.

In one of our patients nearly the whole of the intestine was collapsed and empty : the stomach, duodenum, and upper part of the jejunum alone were enormously distended, and the meteorism was *localized exclusively to the supra-umbilical zone.* At the junction of the dilated and empty segments I found *a vertically placed band, about 2 inches long and the thickness of a goose quill* (*Fig.* 378), descending from the posterior abdominal wall to be attached to the anterior surface of the intestine, which presented at the point of insertion an acute angulation which completely obstructed the lumen, while the distention of the upper segment made the spur more complete.

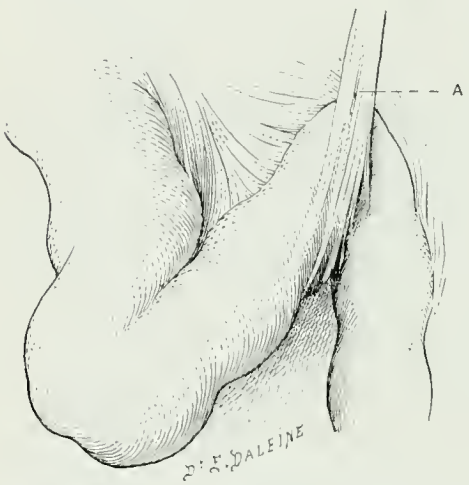

Fig. 378. – Acute angulation of the intestine by a band. (A) Vertical band causing angulation of the intestine.

The section or excision of the band must be carefully performed. I say **excision** advisedly, because if the peri-intestinal expansions of the band are not followed up and divided or excised, there will be a danger of allowing some flexions or foldings of the intestinal wall to persist and cause trouble subsequently.

The mechanism of obstruction is the same in cases where both ends of the loop lie side by side, like the double barrels of a gun, bound together by adhesions ; such a condition of the reduced loop is sometimes found after operation for strangulated hernia, and may be the cause of secondary obstruction (see STRANGULATED HERNIA). Whatever its origin, this anatomical variety requires for the relief of the obstruction a very troublesome separation or dissection of the adhesions.

Lastly, it is easy to understand how the **torsion** of a loop around its mesenteric axis or on itself may be produced and maintained by adhesions. We shall refer to this immediately in connection with volvulus.

In a patient of L. Rehn[1] a large distended loop escaped when the abdomen was opened ; on following it from above downward *two bands of adhesions* were first found passing from the mesentery to the sigmoid colon,

[1] L. REHN, " Ueber Behandlung des acuten Darmverschlusses." *Arch. f. klin. Chir.*, 1892, Bd. xliii., p. 298.

and a little lower down the point of obstruction was encountered : *a third delicate band* extended from the left side of the abdominal wall to the mesentery, and was attached also to the surface of a loop of small intestine which had a half twist on its mesenteric axis : the band was easily broken and the torsion reduced. The patient died ; and at the autopsy *a fourth band* and a second area of strangulation were discovered : this band was thick, and occupied the cæcal region, forming a bridge above the pelvis, and under it a loop of small gut was strangulated.

Multiple obstruction by bands, however, appears to be uncommon. Still, in cases belonging to this group, it would be a mistake to expect always to meet with a single definite fibrous cord which could be dealt with easily. Often there will be quite a broad fibrous expansion with extensive adhesions, and the fæcal blockage then causes **multiple angulation.**

This is often so when a long loop of intestine is applied to, and fused with, the surface of a tumour, an ovarian cyst, a pelvic cancer, a focus of suppuration, a hæmatocele, or an old area of appendiceal inflammation, or is adherent in a region from which the peritoneal covering had been largely stripped at a previous operation.

The most frequent cause of **post-operative obstruction** is adhesion and acute angulation of intestine in the vicinity of pedicles, to areas stripped of peritoneum, to sites of abdominal drainage. Special reference is necessary to the thick pedicles after ovariotomy[1] and also to the cut surfaces of the broad ligaments after vaginal hysterectomy.[2] In the case of a woman who had died from obstruction on the eighth day after operation, we observed that a long segment of small intestine was adherent to the pedicles, and though the adhesions were still soft and easily separated, they had, nevertheless, caused multiple flexions and complete obstruction.

This is not, however, the only mode of origin of these obstructions. Putting aside those which are due to an operative fault, such as a ligature constricting the intestine, a forgotten swab, etc., others are due to the strangulation by bands which has been already described : it may be an old band, a finger of omentum, a strip of mesentery, or a long adhesion which, having acquired fresh attachments at some point, forms a bridge. Others, again, are attributable to intestinal contracture, or more frequently to intestinal paralysis (see PSEUDO-OBSTRUCTION) : further, infection plays an important part in the causation of post-operative intestinal paralysis.

Lastly, MM. Adenot and Jaboulay[3] have pointed out a form of obstruction which, having been observed in several cases, should be kept in mind : *an exaggerated angulation of the splenic flexure of the colon.* Briefly, the state of affairs is as follows : under normal conditions, the angle formed by the transverse colon and the descending colon is suspended by a fan-shaped

[1] Secured in the old way, by ligature *en masse*, and not covered with peritoneum.

[2] GIRESSE, *Contribution à l'étude des occlusions intestinales post-opératoires consecutives à l'hystérectomie vaginales.* Thèse de doct., 1896.

[3] ADENOT (of Lyons), "Contribution à l'étude des occlusions intestinales après la laparotomie." *Gazette hebd.*, 1895. Also "Des occlusions intestinales post-opératoires." *Revue de chirurgie*, 1896, p. 15.—See also LEGUEU, "Revue générale," in *Gazette des hôpitaux*, nov. 1895. Also LENCLOS, Thèse de Nancy, 1899.

ligament, the phrenico-colic ligament, which is inserted on either side of the flexure into both limbs of the colon, and keeps it open: in certain conditions the fan-shaped band is reduced to a mere cord inserted into the apex of the angle, and by its tension tends to close the angle more and more (*Fig.* 379). After the removal of a large abdominal tumour, the slipping down of the transverse colon completes the closure, and produces a condition of acute angulation at the flexure; the pressure of the distended coils of small intestine intensifies the blockage.[1]

With regard to treatment in the presence of symptoms of post-operative obstruction, an electrical enema should first be tried in the manner already described. If the operation has been a vaginal hysterectomy, the vaginal packing should be removed, and any adhesions which may have formed between the intestines and the cut surfaces of the broad ligaments or the floor of the pelvis be separated with the finger, or with a gauze swab in a holder. If employed at an early stage this plan will often be successful.

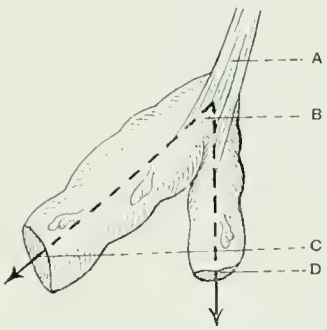

Fig. 379.—Acute angulation of the splenic flexure of the colon, caused by the traction of an abnormal phrenico-colic ligament. (After Bérard and Patel, *loc. cit.*) (A) Phrenico-colic ligament. (B) Splenic flexure forming an acute angle. (C) Transverse colon, displaced downwards. (D) Descending colon.

After a laparotomy, and if electrical treatment has failed, the abdomen must be opened. *The operation area will be inspected first of all;* if nothing is found there, then a systematic search must be made for the cause of obstruction along the general lines already laid down, and *an examination of the splenic flexure must not be omitted.* In the event of the obstruction being found at the flexure, it may be corrected by dividing the phrenico-colic ligament and displacing the compressing loops of small intestine. If the splenic flexure has been drawn very high up, and is consequently difficult of access, the best plan will probably be to perform entero-anastomosis between the transverse and descending colons.[2]

Bands are not always simply fibrous structures resulting from localized peritonitis, old or recent; **adherent omentum, the appendix, or Meckel's diverticulum** may cause obstruction in an exactly similar manner, as we shall indicate presently. The removal of the obstacle in these cases requires special precautions.

[1] Independently of any operation, this acute angulation of the splenic flexure of the colon, since it depends on an abnormal arrangement of the suspensory apparatus, may be the cause of obstruction, usually chronic but sometimes acute. (See L. Bérard and M. Patel, "Les occlusions intestinales par coudure de l'angle coliqne gauche." *Revue de chir.*, 10 mai, 1903, No. 5, p. 590.)

[2] This appears indeed to be the best plan to adopt in all cases of obstruction due to this cause, as division of the phrenico-colic ligament is usually difficult and dangerous. (Terrier, *Société de chir.*, 16 avril, 1902, p. 467.)

The obstructions due to *diverticula* are produced in various ways;[1] most commonly the condition is one of strangulation, either by the free diverticulum which twines itself around a loop of intestine, forming one of those simple or double intestinal knots described by Parise (*Fig.* 380), or by the diverticulum, attached by its extremity to the abdominal wall, to the mesentery, or to a neighbouring organ, forming a ring in which the intestine is closed; sometimes again the diverticulum being fixed at its extremity forms a tense band over which the intestine may be acutely kinked (*Fig.* 381).

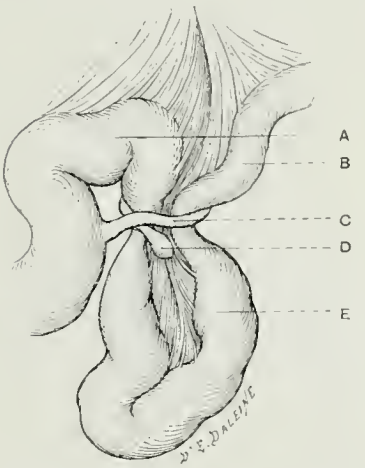

Fig. 380.—Obstruction caused by Meckel's diverticulum. (A) Upper end of the strangulated loop, distended. (B) Lower end, contracted. (C) Diverticulum twisted around the loop. (D) Dilated tip of the diverticulum. (E) Strangulated loop. (After BÉRARD and DELORE. "De l'occlusion intestinale par le diverticule de Meckel." *Revue de chir.*, mai et juin, 1899.)

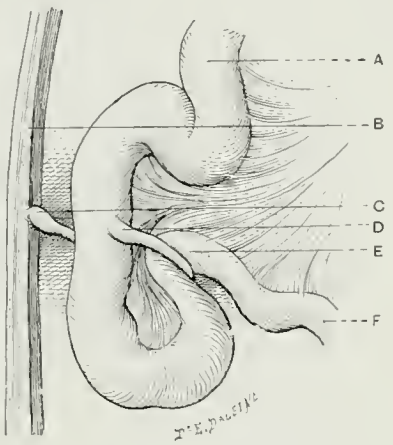

Fig. 381.—Obstruction caused by Meckel's diverticulum. The diverticulum is fixed to the wall and forms a band. (A) Upper end. (B) Abdominal wall. (C) Tip of the diverticulum adherent to the wall. (D) Intestinal attachment of the diverticulum. (E) Acute angulation of the lower end over the diverticulum. (F) Acute angulation of the lower end over the diverticulum. (F) Lower end. (After BERARD and DELORE, *loc. cit.*)

Another way in which the diverticulum may cause obstruction is by *invagination*: it is turned outside in, like the finger of a glove, invaginated into the lumen of the intestine, and drags behind it a greater or less extent of the intestinal wall; lastly, *volvulus*, limited to the diverticulum, or extending to the intestine, deserves mention.

One can understand that the treatment will vary in difficulty greatly, according as it may be limited to simple excision of a diverticulum acting as a band or causing an intestinal knot, or if it must be extended to invaginated or twisted intestine, and also according to the nature of the intestinal lesions[2] (see INTUSSUSCEPTION, VOLVULUS). The freeing and removal of

[1] See E. FORGUE and V. RICHE. *Le diverticule de Meckel (appendice de l'iléon) : son rôle dans la pathologie et la thérapeutique abdominales.* Paris, 1907.

[2] In 140 cases of operation for obstruction due to Meckel's diverticulum collected by MM. Forgue and Riche there were 54 recoveries (40 %). The high mortality is undoubtedly to a great extent due to the late stage at which operation was undertaken. On the other hand, all the cases in which no operation was performed died.

the diverticulum always require special attention, it communicates with the cavity of the intestine, and usually contains fæcal matter; further, in the cases of which we are speaking, it is commonly distended with exceedingly septic fluid: the best plan is to apply two pairs of Kocher's forceps to the base, close to its intestinal attachment, to cut between them, and then to cauterize the two stumps carefully with the thermo-cautery. Then proceed to separate and remove the organ; during the separation it may be necessary to divide it: if so, the section will be preceded by double clamping and followed by cauterization of the cut surfaces; the free extremity is often adherent to the mesentery or surface of the intestine, and must be very carefully enucleated in the same manner as in dealing with the extremity of an adherent tube.

After the intestine has been liberated and the diverticulum removed, the stump of the latter will be treated in the manner described later (see APPENDICITIS).

The rings, which may be the cause of actual internal hernia, are also of different types: *the foramen of Winslow, the peritoneal fossæ, or abnormal openings in the mesentery or omentum*, may represent the neck in these herniæ. Lesions of all degrees of severity, from simple retention of a loop of intestine to tight constriction and gangrene, may occur; Jonnesco[1] has, however, concluded from a study of the literature that generally the constriction is not tight, the condition being more frequently one of *acute angulation of the intestine over the margin of the ring*: and that reduction may be effected without the necessity for incising the constricting structures.

These retroperitoneal herniæ are exceedingly uncommon: the chief varieties are duodenal, pericæcal, intersigmoid hernia, and hernia into the foramen of Winslow, the last being the rarest of all.

On opening the abdomen a huge sac is found surrounded by the colon, and containing the whole or a great part of the small intestine; an incision through the anterior wall of this sac would expose the coils of small intestine enclosed in an enormous pocket; but the incision may be dangerous by involving vessels of some size, and, further, it would be of little help in effecting reduction; the ring must be sought for at the known situations of the various retroperitoneal fossæ. The task is not an easy one, the more so because the extreme rarity of the condition renders it impossible to lay down definite guiding rules. If the orifice is narrow, and resists all attempts at extracting the incarcerated intestine, it must be incised, keeping in mind the fact that *it is usually bounded by very large vessels hidden by the peritoneal folds*. It is impossible to rely on the points of election which have been determined by the study of the anatomical arrangement of the parts: the safest plan is **to carefully explore the whole circumference of the ring with the fingers, feeling for arterial pulsations**: the incision will then be made very cautiously on the side which appears to be free from any vascular danger.

[1] JONNESCO, *Hernies internes rétro-péritonéales*. Thèse de doct., Paris, 1890.

The difficulties are particularly great in the case of a hernia strangulated in the foramen of Winslow, encircled by exceedingly important structures; Bardenheuer recommends enlarging the opening backwards and to the right, which is, after all, not very explicit: Treves, in a case of this kind, was compelled to abandon the operation: "In the tissues situated in front of the ring, a vessel—evidently the hepatic artery—could be felt pulsating. I attempted reduction, and succeeded easily in withdrawing two or three feet of small intestine; but the reduction of another loop which also passed through the ring was absolutely impossible. It was equally impossible to enlarge the orifice, since even modern surgery has not yet demonstrated that it is possible with impunity to cut simultaneously

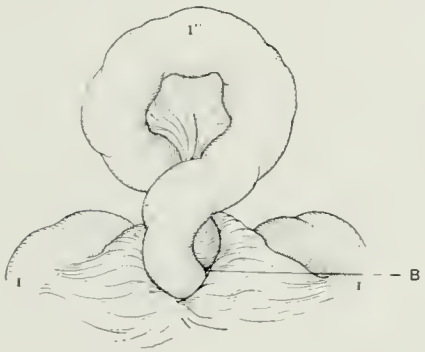

Fig. 382.—A loop of intestine, strangled in a mesenteric opening and twisted. (Morestin's case.) (B) Mesenteric opening. (I, I') The two ends of the loop. (I'') The strangled and twisted portion of the loop.

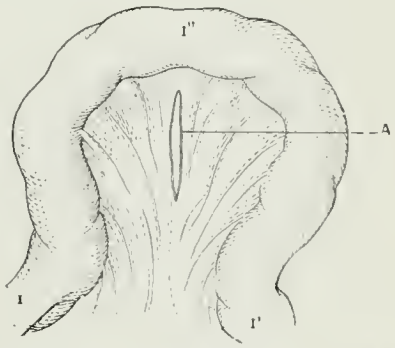

Fig. 383.—The loop represented in *Fig.* 382 after reduction: the mesenteric slit. Morestin's case.) (A) The mesenteric slit. (I, I', I'') The loop untwisted and reduced.

the hepatic artery, the portal vein, and the bile-duct. The operation was therefore abandoned: the patient never rallied, and died about six hours later."

Perhaps, in such a case, enterotomy might have been done as a last resource.

Rehn[1] was more fortunate, and succeeded in liberating *a loop of small gut strangulated in the foramen of Winslow*. The patient was an old man seventy-seven years of age. On opening the abdomen several distended and discoloured loops of small gut were seen; one of these was followed in the direction where the congestion seemed to be greatest, until suddenly a resistance was felt. It was then recognized that the loop penetrated into the foramen of Winslow, behind the stomach, and was very tightly fixed. By the exercise of rather greater traction it was disengaged: it was about 6 inches long, and appeared to be in good condition. The intestine below was empty, but as soon as the constricted loop was liberated, it began to fill. The abdomen was closed. The patient died at the end of forty-eight hours.

[1] Rehn, *loc. cit.* f v p. 310.

At the autopsy, the strangulated loop was found to have been at about 4 feet from the termination of the ileum; above, the intestine was considerably distended; below, it was collapsed and empty. It was a case of secondary obstruction by paralysis of the gut.

Morestin[1] has published a very curious case of strangulation *through an abnormal opening in the mesentery*; he discovered, first of all, a loop of small intestine, distended, and gathered into a large irregular mass; on examining it closely he recognized the following complicated arrangement: the middle part of the loop was bent back on itself and had passed through a slit-like opening in the mesentery, and, further, the whole segment thus strangulated was twisted on itself (*Figs.* 382, 383). Morestin began by correcting the torsion, then he enlarged the mesenteric opening and reduced the loop. The patient recovered.

(*B*). **Volvulus and Torsions.**—With regard to obstructions of this kind, there is, first, a general rule to be laid down: **make a large incision and a free evisceration**: these are necessary conditions both for the recognition of the exact nature of the lesion and the subsequent treatment. On opening the abdomen some distended loops are seen to escape: the size of these loops is often enormous: and if access is insufficient a very false and imperfect idea of the condition is obtained.

In **volvulus** the intestine is twisted around its mesenteric axis; the length of intestine involved, and the number of turns, are variable: the lesion may affect the large intestine—usually the sigmoid colon—or the small gut.

Volvulus of the sigmoid colon is the most common form. The obstructed loop may be of such enormous size as to prevent any manipulations and to hide the whole field of operation; to evacuate it, or at least to reduce its volume by a short incision—which will be sutured immediately it has served its purpose—is sometimes an indispensable preliminary. Only one segment of the mass can be emptied through the incision, and it has been necessary in some cases to make two or three openings.

Although these drainage incisions are almost indispensable in cases of extreme distention, they are nevertheless a source of very real danger, for even the most minute precautions cannot absolutely guard against infection through the stream of fæcal liquid which spurts forth. They are not, therefore, to be recommended unless absolutely necessary: it will be often safer and quicker to extend the laparotomy incision, and to turn the whole intestinal mass out of the abdomen. The exact state of affairs then becomes evident at once, and by pushing the distended coils to one side the twisted meso-colic pedicle can be exposed. The direction of the twist is a point of great importance which cannot always be easily defined at once: generally, it is right-handed, that is, *from the patient's right to left in the same direction*

[1] *Société de chirurgie*, 10 oct., 1899.

as the hands of a watch, but this is not a constant rule ; a definite conclusion can only be reached by examination of the twisted mass. When the distention prevents a satisfactory inspection, one may commence tentatively to nutwist from left to right, when the diminished or increased resistance will soon indicate whether the direction is correct or not.

Untwisting should always be attempted as the first step if the loop is not gangrenous ; a study of the recorded cases shows that the attempt is often successful, at least when the lesions are comparatively recent, and when the proper technique is adopted.

Let us emphasize at once that no good will be done—to say the least of it—by pulling on this or that loop which appears to "come easily," nor by partial unrollings : *the untwisting must be done as a whole*, the mass being held between the two hands.

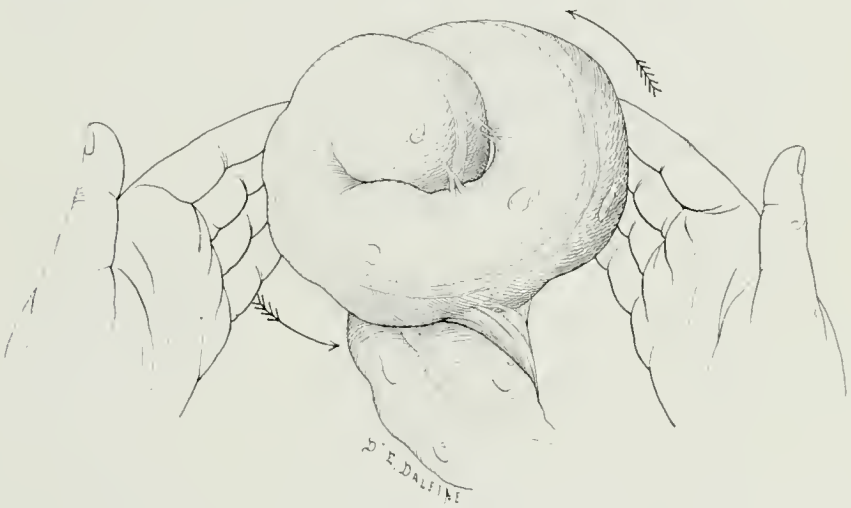

Fig. 384.—Unwinding a volvulus. The two hands are rotating the intestine from the patient's left to right, in the direction opposite to that of the hands of a watch.

Place the outspread right hand on one surface and the left hand on the opposite surface, and rotate the twisted mass as a whole from left to right (*Fig.* 384) : work gently, without any sudden jerks ; it is a steady rotatory movement that is wanted. When the untwisting is succeeding, the curves of the mass will be seen to straighten out bit by bit ; when a half turn has been made, change the hands to the first position, taking care while doing so not to lose what has been gained, and continue the movement.

In this way, one, two, sometimes even three complete turns will be described, until the direct continuity of the intestine is restored, and it is possible to follow the whole length of the loop. The factors which complicate the untwisting are the *thickening and infiltration of the mesenteric pedicle* when the condition is not quite recent, and *the adhesions*. Once the untwisting is achieved, the removal of the obstacle is often signalized by a spontaneous evacuation of gas and liquid fæces ; but if not, it is an excellent

practice to introduce a large-sized rubber tube as high up into the rectum as possible.[1] The tube may even be introduced before beginning the untwisting; the loop can be rapidly emptied by gentle pressure through the channel thus provided, and is more easily replaced in the abdomen.

We have already referred to the thickening and infiltration of the mesocolon, by reason of which the untwisting is rendered difficult; let us add that for the same reasons there is a great tendency for the twist to reform.[2] As a matter of fact *recurrence of a volvulus* is by no means uncommon.

To neutralize this tendency, the operation will be completed *by fixing the sigmoid colon to the anterior abdominal wall.* Strictly speaking, it is not the colon, but the mesocolon close to its intestinal attachment, which is fixed to the parietal peritoneum; the left lip of the abdominal incision is strongly everted by two retractors, or by traction on two stout threads passed through the thickness of the abdominal wall, *and a series of interrupted sutures of catgut or silk are passed through the parietal peritoneum at the position of the outer border of the rectus muscle on the one part; and through the mesocolon, care being taken to avoid the large vessels, on the other.* This very simple procedure is preferable to fixing the colon directly, as the introduction of sutures through the distended and thinned wall of the intestine is always a rather delicate undertaking.

Untwisting thus executed is the method of choice in dealing with a volvulus; it may be added that in such cases there are only two available procedures: untwisting or resection. The gravity of the latter is too well known for it to be considered as anything but a method of necessity, to be adopted only when the loop is gangrenous, or the adhesions are inseparable. Enterostomy or entero-anastomosis are inapplicable, since the existence of an unreduced torsion is equivalent to inevitable gangrene of the twisted loop.

The same indications apply to **volvulus of the small intestine**: to withdraw the bundle of twisted loops from the abdomen, examine it, and proceed to *untwist it en masse, from left to right* usually, in the opposite direction to the movement of the hands of a watch; from right to left if the twisting has taken place in the atypical direction.

Not uncommonly bands, adhesions of varying length and character, a Fallopian tube, sometimes the appendix, or again a Meckel's diverticulum (see above), fix and retain the twisted loop,[3] and prevent reduction, unless recognized and dealt with as may be necessary.

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[1] This plan has been recommended by Braun. ("Ueber die operative Behandlung der Achsendrehung der Flexura sigmoïdea." *Arch. f. klin. Chir.*, 1892, Bd. xliii, p. 164.)

[2] "After torsion," writes Roux, "the mesentery remains elongated, and the loop which had been affected continues to float about more or less uncontrolled, ready to become again twisted on itself, or around any neighbouring loop, or the omentum, or any other organ within its reach." ("Onze cas d'occlusion intestinale aigue." *Revue méd. de la Suisse romande*, 20 jan., 1894, p. 1.) In the cases of volvulus reported in this paper the torsion was of the "rectum in front" type, and the untwisting was done from left to right.

[3] See Berard and Delore, "De l'occlusion intestinale par torsion du mésentère." *Congrès de chir.*, 1899, p. 411.

Lastly, there is a special variety of torsion of the small intestine to which Pierre Delbet[1] has called attention : **torsion of the whole mesentery.** The volvulus affects the entire small intestine, and produces an appearance which, on opening the abdomen and during the first examination, may lead the operator to think first of a retro-peritoneal hernia.

" Immediately the abdomen was opened," writes P. Delbet, " some coils of small intestine escaped from the wound . . . ; I enlarged the incision to an inch above the umbilicus, and allowed some more loops to emerge ; these were immediately covered with warm compresses. I then introduced my right hand into the peritoneal cavity, and being convinced that the obstruction was situated very low down, I examined first of all the sigmoid colon. It was completely collapsed and empty. I then directed my attention to the cæcum, but found it also collapsed. I got hold of the terminal part of the small intestine close to the cæcum, and tried to draw it up into the wound ; but it was immobile, fixed against the posterior abdominal wall, so that I could neither draw it up nor follow it. I allowed some more of the coils of small intestine to escape ; they, like the first, were received between warm compresses, and drawn over to the left side of the abdomen. A visual examination then became possible, and I found the arrangement which I have described. The cæcal loop of the small intestine, collapsed and twisted, curved behind a peritoneal fold, together with another loop which was, however, red and distended. The cæcal loop, stretched between the cæcum on the one hand and the peritoneal fold on the other, was fixed and flattened against the posterior abdominal wall ; the other loop, which could only be the first jejunal loop, was mobile in its middle part ; the mesentery, evidently twisted, was seen between the two extremities of this distended loop. Complete evisceration was immediately performed, and the mass of small intestines, held between the widespread hands, was raised and untwisted from below upwards and from left to right. After a turn and a quarter made in that direction the intestine and mesentery were restored to their normal relationships."

To two cases of P. Delbet, must be added those of Reynier,[2] Monod, Mignon,[3] etc., and from them we must conclude that in these rare forms of obstruction, exact diagnosis and beneficial action are only possible by means of *complete evisceration.*

In addition to volvulus, and far behind it in point of frequency, it is advisable to mention : (1) *The torsions of the intestine on its own axis ;* (2) *The reciprocal entanglement of two segments of the same loop, or of two neighbouring loops.* The causation of these " rotatory entanglements " is very obscure : practically, it is necessary to take the conditions as they are, and to try to " unravel " the situation in the simplest way possible.

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[1] P. Delbet, " Occlusion intestinale par torsion de la totalité de l'intestin grêle et de son mésentère. *Bull. de la Soc. de chir.*, 1 juin, 1898, p. 618, also Rapport de Routier. *Ibid.*, 15 juin, 1898, p. 658.

[2] *Bull. de la Soc. de chir.*, 24 juin, 1898, p. 684.

[3] *Ibid.* 29 juin, 1898, p. 705.

1. **Axial torsion** has been observed particularly on the cæcum at the junction of its free and fixed portions. These *cæcal torsions* have been investigated by Zoege von Manteuffel:[1] the rotation rarely exceeds 80°, but it may reach 180°, and then involves the terminal part of the small intestine and its mesentery in the rotatory movement. By recurring they produce cicatricial stenoses; therefore, Zoege von Manteuffel in such cases, and when examination of the cæcum shows a considerable alteration in its shape and in its wall, recommends primary resection in preference to untwisting, followed by fixation. I have recently observed a similar axial torsion of the small intestine: the loop was blackish and gangrenous; it measured 24 inches in length, and was resected.

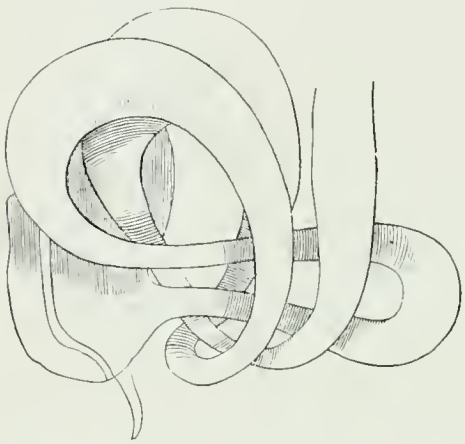

Fig. 385.—Compound intestinal knot. (Zoege von Manteuffel, "Zur Diagnose und Therapie des Ileus." *Arch. f. klin. Chir.*, 1891, Bd. xli., p. 589.)

With regard to the treatment of the **complex entanglements** of several loops, or of several segments of one loop (*Fig.* 385), no definite rules can be laid down.

(*C*). **Intussusception.** — Let us briefly recall that this is frequent in early childhood; that it may be multiple; that, though usually *descending*, it may exceptionally be *ascending or retrograde* (*Fig.* 386); that it is sometimes of very considerable dimensions, an ileo-colic intussusception perhaps extending into the rectum.

In these cases the obstruction is characterized by the presence of **a tumour**, which can often be very definitely felt during the preliminary examination of the abdomen, and which is usually discovered with very little trouble after the abdomen is opened.

Therefore, if the existence of a thick, elongated, mobile tumour has been recognized beforehand, go at once towards it, and draw it into the wound, outside the abdomen. I am speaking now of intussusceptions of average length, such as are most frequently met with: *eventration* of the intussuscepted mass is always practicable in such cases, and should be the first step in the operation. Then examine the mass, determine its character, and take careful note of the state of the **sheath** and the **neck**. Here again, **simple reduction**, sometimes termed disinvagination, constitutes the method of choice when it is practicable, which it usually is when the lesion is recent.

I presume, therefore, that the surface of the ensheathing layer, though

[1] Zoege von Manteuffel, "Die Achsendrehungen des Cæcums. *Arch. f. klin. Chir* 1898, Bd. lvii., p. 841.

of a more or less deep red colour, is still in good condition ; that it is smooth, warm, and well vascularized, with no doubtful patches ; and that the same is true of the neck. It is true there are no means of knowing the condition of the invaginated portion. That will be learned later if reduction is successful. As a matter of fact, serious lesions of the invaginated layers are scarcely ever present without adhesions having developed sufficient to prevent reduction. **Therefore, if the sheath and the neck are undamaged, and if the condition is comparatively recent,** *one must first endeavour to effect reduction* (*Fig.* 387).

Fig. 386.—Retrograde intussusception of the ascending colon. Gangrene. Enterectomy.

On no account must the two extremities of the mass be seized and pulled in opposite directions : such an apparently natural and mechanical procedure might succeed if dealing with an inert tube. Here, however, one has to do with a living and diseased wall, and the method adopted must be quite different.

Begin, then, by exercising gentle circular pressure on the intussusceptum with the fingers, just as in reducing a hernia by taxis one tries first of all to empty and compress the herniated portion : now try to express it through the neck without force and without haste. Reduction will not come about at once ; the invaginated layers must be allowed time to flatten out under the pressure of the fingers. This gentle steady expression is the essential part of the work of reduction ; while it is being carried out the upper and entering end is held close to the neck and kept slightly stretched ; it must

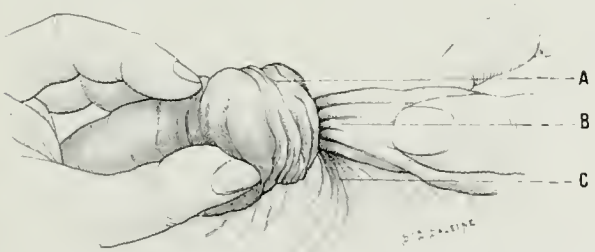

Fig. 387.—Reducing an intussusception. The left hand is expressing the invagination, while the right keeps the lower end slightly stretched, but without pulling on it. (A) Swelling caused by the invagination. (B) Lower end. (C) Mesentery.

not be pulled upon, but as the invaginated layers emerge from the neck of the sheath under the pressure of the lower hand, the upper hand merely takes up the slack. When thus performed, disinvagination is harmless; like all other intestinal manipulations it ought to be done gently. Numerous cases have demonstrated that the neck may be very easily torn by rough traction; often, indeed, a very slight force is sufficient to damage the infiltrated wall. Still, it is necessary to persist with the attempts at expression of the invagination, which must not be considered irreducible until serious and repeated efforts have failed.

If reduction is successfully achieved,[1] the wall of the reduced loop will be carefully inspected, and if its condition is satisfactory, nothing more remains to be done but to cleanse the surface of the loop and replace it in the abdomen.

Fig. 388.—Tumour of the ileocæcal valve, with ileocolic intussusception. (*a*) Tumour of the valve forming the head of the intussusceptum. (*b*) Wall of cæcum and ascending colon. (*c*) Appendix. (*d*) Ileum.[2]

If there are any doubtful points, any blackish patches where the peritoneal covering has lost its natural lustre or is ruptured, care must be taken to bury them by one or two rows of Lembert sutures. If the gangrenous spots are multiple, or if the vitality of a segment of some extent appears doubtful, the affected part may be kept outside the abdomen surrounded by folds of aseptic gauze, and secondarily reduced at the end of twenty-four or forty-eight hours, if the fears as to its condition prove groundless.

Attempts at reduction will be unsuccessful when the opposed serous surfaces of the entering and returning layers of the intussusceptum are firmly adherent, or when the thickened and infiltrated invagination is too voluminous to pass through the more or less contracted neck, and sometimes when the intussusception is complicated by the presence of a neoplasm,[3] as shown in *Fig.* 388.

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[1] As a matter of fact the prognosis of operations performed for intussusception depends to a great extent on the reducibility or irreducibility. In 53 cases occurring since 1899 collected by M. Auvray there were 28 cases where reduction was possible, with 23 recoveries and 5 deaths, a mortality of 17·85 %; 25 irreducible cases with 9 recoveries and 16 deaths, a mortality of 63 %. (M. Auvray, "Occlusion intestinale aigue par invagination, laparotomie, réduction de l'invagination. Guérison. *Gazette des hôp.*, 3 juillet, 1900, No. 75.

[2] Figure taken from our paper: "De l'intervention chirurgicale dans les tumeurs du cæcum compliquées d'invagination iléo-colique." *Revue de gynécologie et de chirurgie abdominale*, déc., 1897, No. 6.

[3] When the neoplasm is an intestinal polypus (adenoma, lipoma, myoma, etc.), reduction is often possible, and, once achieved, the intestine ought to be incised, the polypus removed

Case 30.—A man, some 30 years of age, was sent to us at the Beaujon Hospital, in August, 1896, with symptoms of undoubted intestinal obstruction. The abdomen was greatly distended, so much so that it was impossible to make out any definite intra-abdominal tumour. I performed infra-umbilical laparotomy forthwith, and on introducing my hand into the abdomen to search for the cæcum, felt almost immediately, in the midst of distended loops of small intestine, *a hard tumour*, which I drew out. It was an ileocolic intussusception 4 to 5 inches long, the ensheathing layer of which appeared to be in good condition. I tried to reduce it by expression, but failed. I then attempted to free the neck and liberate the invaginated layer with a director. I broke down some adhesions, which bled considerably, but was soon compelled to stop without having made the slightest progress in reduction, and to excise the mass.

What measures are available under such circumstances? And here, if a momentary digression is permissible, I wish to emphasize the need of foreseeing and being prepared for any possible eventuality in abdominal surgery, where a surprise always entails loss of time. What is to be done? An artificial anus is a resource of only doubtful value, because the intussusception is left unreduced in the abdominal cavity, probably to become gangrenous and to perforate; still the procedure has a certain chance of success, dependent on the possibility of the intussusceptum alone sloughing, separating, and being spontaneously eliminated. It is perfectly true that such spontaneous cure of an intussusception does sometimes occur: but the responsibility of trusting to the chance is heavy, and it can only be when the patient's condition is extremely bad that one will be justified in assuming it. The same argument applies even more forcibly to entero-anastomosis, which requires for its performance quite as much time as the more rational procedures now to be described.

These procedures are **the resection of the whole intussusception** or **the resection of the invaginated layers through an incision in the sheath.**

If the ensheathing layer has been damaged in the attempts at reduction, or if its vitality is at all doubtful, all hesitation must be put aside: *complete resection* is necessary.

Under opposite conditions the following operation may be employed:[1] it possesses decided advantages, particularly when dealing with very long intussusceptions.

Begin by applying a continuous sero-serous suture all round the neck (D, *Fig.* 390), uniting it in its whole circumference to the serous coat of the invaginated end; in this manner any risk of subsequent separation and disinvagination is obviated.

after ligature of the pedicle, and the incision sutured, as was done by Israel in the following case, which may serve as an example: Woman, 79 years of age; frequent attacks of obstruction, the last of six days' duration. Laparotomy: an intussusception of the colon 6 inches in length was found and reduced, and then a polypoid tumour as large as a plum was felt in the interior of the intestine. Incision of the intestinal wall at the site of the tumour, removal of the polypus, suture. The patient recovered. The polypus proved to be a pure myoma. (Holländer, *Centralblatt f. Chir.*, 1896, No. 13, p. 310.)

[1] This resection of the intussusceptum has been done by König, Leszczynski, Senn, Rosenthal, Jessett-Barker, Widenham, Maunsell, Rydygier; we describe here the Jessett-Barker method, adopted by Rydygier. (See Rydygier, "Zur Behandlung der Darminvaginationen," *Verhandl. d. deutschen Gesellschaft f. Chirurgie*, 1895).

Now incise the ensheathing layer longitudinally on the free border; make the incision of sufficient length to provide free access to the intussusceptum, and secure the two lips at once with fine forceps or with loops of thread which will serve as retractors. The intussusceptum is then plainly seen (*Fig.* 389): divide it transversely in its anterior two-thirds close to the base (*Fig.* 390); in this manner the two walls of the intussusceptum are divided (C, *Fig.* 390), and an opening is made into the central cavity, into which the finger is introduced in order to determine the degree of patency of the neck.

The next step is to insure the permanent adhesion of the two inner layers by four sutures passed through the entire thickness of the two walls

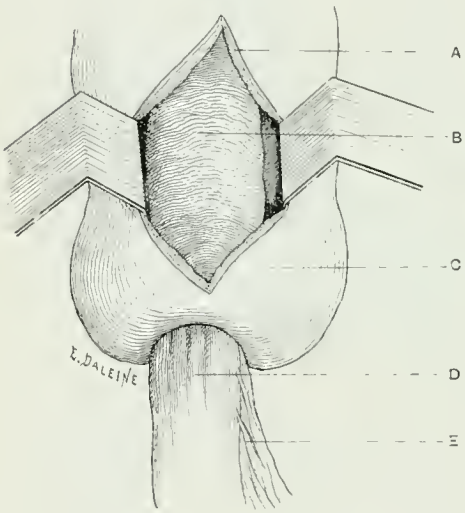

Fig. 389.—Intussusception. Resection of the intussusceptum. (1st step.) (A) Incision in the ensheathing layer. (B) Intussusceptum. (C) Sheath. (D) Upper end. (E) Mesentery.

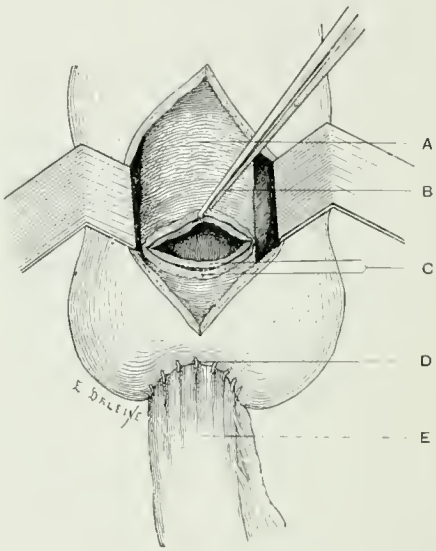

Fig. 390.—Intussusception. Resection of the intussusceptum. (2nd step.) (A) Intussusceptum. (B) Forceps retracting the lower lip of the incision in the intussusceptum. (C) The two layers of the intussusceptum. (D) The neck sutured. (E) Upper end.

(*Fig.* 391): the first is placed in the anterior border of the stump, the following two at its lateral borders; the fourth must be applied at the mesenteric attachment and serve as a ligature to the segment of mesentery drawn in with the invaginated end. The simplest plan is to pass and tie this last suture from within the central cavity of the opened intussusceptum; the needle must therefore be made to penetrate the posterior walls from before backwards, to slip behind the undivided portion of the intussusceptum, and be brought back into the central cavity on the other side of the mesenteric attachment: the whole bridge of tissue thus included in the grasp of the suture can then be securely tied.

It only remains to complete the excision of the invagination by cutting its posterior third and then seizing and extracting it with a pair of toothed

forceps. For additional security the cut edges of the two walls in the stump may then be united rapidly by a continuous suture.

The longitudinal incision in the sheath is closed in the usual manner (*Fig.* 392); if the volume of the thickened stump appears likely to put undue tension on the wound, the suturing may be done transversely to the long axis of the incision, in the manner already described elsewhere.

Complete resection, when it constitutes the only rational method of treatment, will be performed in the manner described elsewhere. It must be recognized that, under the circumstances, it is a very grave undertaking. The only means of ameliorating the operative prognosis consists in reducing the duration of the operation to a minimum and

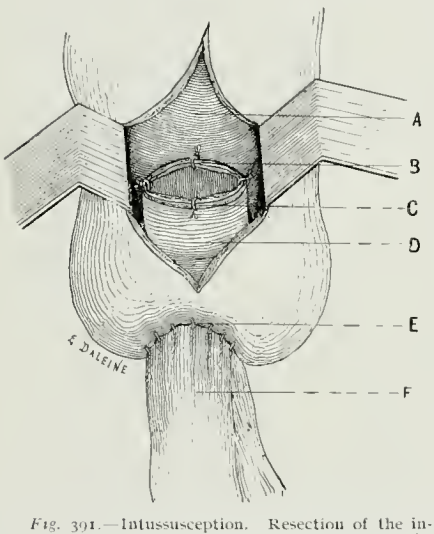

Fig. 391.—Intussusception. Resection of the intussusceptum. (3rd step.) (A) Posterior wall of the sheath. (B) Posterior suture in the intussusceptum. (C) Anterior suture in the intussusceptum. (D) Stump of the intussusceptum. (E) The neck sutured. (F) Upper end.

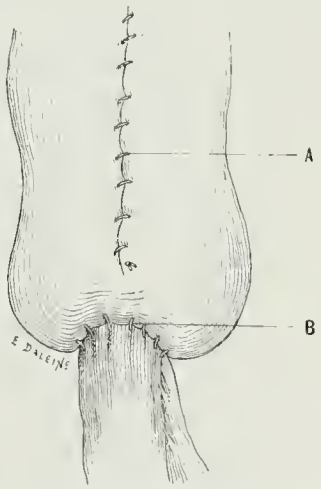

Fig. 392.—Intussusception. Resection of the intussusceptum. (4th step.) (A) Incision in the sheath sutured. (B) The neck sutured.

by taking the most minute precautions to prevent the slightest septic contamination of the peritoneum and the neighbouring loops; all the work of resection and suturing must be executed *outside the abdominal cavity*.

If the patient's general condition is very bad, there remains the resource of *fixing the two ends in the parietal wound*[1] after resection of the

[1] We must here refer to those long intussusceptions of the large intestine which prolapse from the anus, and in which resection of the prolapsed portion, followed by reduction of the stump, constitutes the method of choice. It is very uncommon for these invaginations to occur in an acute form, and usually a new growth is situated at the apex of the intussusceptum. The symptoms were, however, acute, and operation was undertaken under urgent conditions, in a case reported by Mickulicz: A woman of 52 years, after having been constipated for some time, was suddenly attacked with violent colic, and during the subsequent efforts at defæcation she noticed that she was losing blood and that a segment of intestine was protruding

intussusception. When the head of an irreducible intussusception is formed by a new growth, resection is obviously indicated for a double reason: in these cases the condition usually assumes a chronic form. We have collected eleven such cases with six recoveries.[1]

(*D*). **Internal Obstruction.**—Most frequently the obstruction is caused by a large gall-stone; but the operative method about to be described is applicable to any other foreign body plugging the interior of the intestine. A very fat woman, 60 years of age, was brought to the hospital with all the signs of acute intestinal obstruction. The symptoms were of two days' duration and the obstruction was complete, neither fæces nor flatus having been passed. Shortly after admission the patient vomited a large quantity of feculent fluid. The temperature was 100·2°, the pulse was fast but fairly strong, and the facies comparatively good. The distention was not excessive; in the right flank there was acute tenderness on palpation, but at no point was any localized rigidity, tumour, or dullness detected. The patient had for a long time suffered with abdominal pains, but her replies were too indefinite to give any precise ideas as to their nature or significance.

Median laparotomy was performed forthwith below the umbilicus. We found, first of all, a very thick and fatty omentum, and after turning it up we saw one distended loop and several collapsed and empty loops of small intestine: these loops were followed, and conducted us rapidly to the junction of the empty and dilated portions; at that point the intestine was occupied by a **large oval mass,** hard and compact, which gave the impression of an enormous biliary calculus.

The affected loop was drawn outside the abdominal cavity and carefully isolated. After several unsuccessful attempts to displace the calculus, a longitudinal incision was made on the free border of the intestine, and exposed the blackish surface of the foreign body, which was removed without much difficulty by tilting it from above downwards between the lips of the incision. From behind what seemed an almost interminable

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from the anus. The prolapse rapidly enlarged, the pain became intense, and vomiting supervened. She was admitted to hospital five hours later in a state of collapse, pulse 120, temperature 100·8°; the lower abdomen was tender, particularly on the left side, where a band could be felt extending from the left hypochondrium to the inguinal region. A cylindrical mass of bowel protruded from the anus and curved backwards and to the left; it measured 15 inches along the convex border and 14 inches in circumference. The circular cul-de-sac at the neck of the intussusception could be felt about 5 inches above the anus. The circulation appeared to be suspended in the lower part of the prolapsus. All attempts at reduction proved unsuccessful. Resection was therefore immediately performed in the following manner, after disinfection of the prolapsed mass with carbolic solution: the outer layer was divided transversely in the anterior half of its circumference, an inch below the anus, and its serous coat was immediately sutured to the serous covering of the inner layer, which was still intact, by a series of interrupted Lembert sutures. In this way the incision was continued around the whole circumference of the outer layer, the suturing being performed step by step as the incision was extended. The inner layer was then in its turn divided, together with the thick band formed posteriorly by the mesocolon; the mesocolic vessels were tied, and the union of the two segments completed by a second row of Lembert sutures and by a continuous suture joining the cut edges of the mucous membrane. The stump was then reduced, and the patient made an uneventful recovery. (J. Mickulicz, "Invagination und Prolaps des Dickdarms durch den Mastdarm. Resection eines 76 centimetres langen Darmstückes; Heilung." *Wiener med. Presse*, 1883, Nos. 50 and 51.)

[1] *Loc. cit.*

stream of fæcal matter escaped, the more so as just at that time there was some difficulty with the anæsthetic, the coughing and straining at each instant projecting a fresh stream of fluid from the bowel. We endeavoured to suture the incision, but under the conditions, and in view of the urgent need for rapidly terminating the operation, it appeared to be impossible to do so satisfactorily; we therefore adopted the plan of suturing the edges of the intestinal incision to the lower part of the parietal wound, and closed the remainder of the latter.

This is, however, quite an exceptional plan, only to be adopted as a dire necessity; generally, as we shall see, extraction of the foreign body will be followed by suture of the opening in the intestinal wall.

In obstructions caused by gall-stones or by foreign bodies in general, the search for the obstacle is to a certain extent facilitated by the presence of a hard body of some size which may be felt during the intra-abdominal examination. Still the exploration ought to be conducted systematically according to the rules already laid down, for any general ideas with regard to the common points of impaction of calculi are only very doubtful guides in the midst of distended loops of intestine.

Often a localized pain, or at any rate a pain which is particularly severe in one definite region of the abdomen, will indicate beforehand towards which side the investigations should be directed in the first place. MM. Kirmisson and Rochard[1] have shown that this pain and the localizing indications are usually situated in the right side of the abdomen. The point of impaction of large calculi is usually in the terminal part of the ileum or in the vicinity of the ileo-cæcal valve;[2] further, the affected loop often occupies a dependent position and is prolapsed into the pelvis or lies in one of the iliac fossæ. Still, we must again repeat, these are only general statements, and the obstruction may be seated in quite the upper part of the intestine, in the duodenum,[3] or even in the colon or rectum.[4]

When the obstructed loop has been found, the first care must be to bring it outside the abdomen and to isolate it in the routine manner. Take note at once of the *condition of the intestinal wall* and the degree of *mobility of the calculus*; usually the obstructed segment is strongly contracted around the foreign body.[5] This spasmodic contracture is a hindrance

[1] Kirmisson and Rochard, *Arch. gén. de méd.*, mars, 1892.

[2] In 35 cases collected by Lobstein, the situation of the calculus was as follows: in the duodenum, 2; the jejunum, 7; the upper part of the ileum, 6; the lower part of the ileum, 10; the vicinity of the ileocæcal valve, 7; the colon or rectum, 3. (Lobstein, "Zur Casuistik des Gallenstein-Ileus." *Beitr. zur klin. Chir.*, 1893, xiii, 2, p. 390.)

[3] This is, however, an exceedingly rare possibility, since in addition to the cases of Naunyn and Taylor, quoted by Lobstein, we can only find one observation of Montprofit (*Soc. de chir.*, 4 juin, 1897), reported by Mangourd in his thesis (*Obstruction du pylore par calculs biliaires.* Thèse de doct., 1897), and that which figures in Garin's thesis (*Contribution à l'étude des complications de la lithiase biliaire. Occlusion intestinale.* Thèse de doct., 1897).

[4] Cases have occurred in which the calculus has been impacted in the upper part of the rectum and has been removed by the natural passages after dilatation of the anus.

[5] This segmental contracture—or paralysis—of the intestine plays an important part in the causation of the blockage, which often cannot be explained by the size of the calculus. After extraction of the foreign body the intestinal contracture or paralysis may persist and give origin to symptoms of prolonged obstruction. (See Rehn, Gallenstein-Ileus. *Arch. f. klin. Chir.*, 1900, Bd. li, p. 305.)

to displacement of the calculus, which should be only attempted with great caution. In any case it can only be of real value when the obstacle is impacted close to the ileo-cæcal valve : Clutton,[1] for instance, found a large concretion arrested just above the valve, and succeeded in pushing it through the opening into the large intestine, whence it was spontaneously expelled five days later.

Apart from such lucky chances, one must not count upon being able to push the calculus along the intestine, nor attempt to break it up by compressing it through the intestinal wall, which is already considerably affected and may easily be seriously damaged by such rough treatment.

Incise the intestine along the free border, over the calculus (*Fig.* 393), after the application of clamps to the gut, above and below the seat of obstruction : the opening should always be of sufficient length to allow of easy extraction of the foreign body ; in other words, the length of the incision

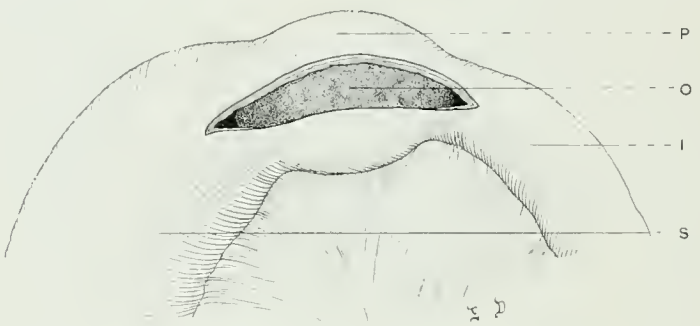

Fig. 393.—Intestinal obstruction by a gall-stone ; incision of the intestine on the stone. (P) Prominence caused by the gall-stone. (O) Gall-stone. (I) Lower end. (S) Upper end.

must slightly exceed the longitudinal diameter of the obstacle, which will then be grasped with forceps and withdrawn, not directly so as to forcibly distend the edges of the wound, but by first tilting one of the poles into the incision. These precautions are the more necessary because the wall is often already damaged, and also because it does not stretch readily owing to the spasmodic contracture just mentioned.

If it is possible to displace the calculus some little way, it is good practice to push it upwards or downwards far enough from the seat of impaction to allow the incision to be made *through healthy wall* and so give greater security for the subsequent closure. Once the calculus has been extracted, the opening in the wall of the intestine will be closed in two layers in the usual manner. If the retraction of the affected segment, after removal of the obstruction, is very marked, and it seems likely that a notable degree of narrowing may be produced after suturing, then the method of suturing transversely to the long axis of the incision may be employed. Gangrene of the loop will necessitate the application of one

[1] Clutton, *Lancet*, 1888, v. 1, p. 123.

of the proceedings which are considered in the following pages. Obstruction by calculi may be considered as one of the forms of intestinal obstruction in which operation is simplest, although in 31 cases collected by Lobstein there were 19 deaths and only 12 recoveries: this heavy mortality is, however, undoubtedly due to the late date at which many of the operations were performed.

The same methods are applicable in cases of obstruction due to enteroliths, masses of entozoa, etc.: bring the obstructed loop outside the abdomen, incise it, remove the obstruction, and close the opening: this is the general line of treatment.

GANGRENE OF THE LOOP.

Hitherto we have assumed that the vitality of the strangulated, twisted, invaginated, or obstructed loop was not seriously impaired, that it was intact, and that its wall presented no gangrenous patches or any areas too doubtful to prevent it being replaced in the abdomen. The situation is much more serious and difficult when the loop is found to be gangrenous, whether perforated or otherwise.

In such a condition the line of treatment will depend on two factors: (1) *The extent of the gangrene*; (2) *The general condition and vital resistance* of the patient. As we shall again meet with the same problems in relation to strangulated hernia, we will here only consider them briefly.

If the is **a small isolated plaque of gangrene without perforation**, at the position of maximum constriction, or a single small perforation in a loop which when liberated and after being bathed with warm boiled water recovers its tonicity and a more healthy colour, then action may be simply limited to excision of the gangrenous patch or the margins of the perforation, the resulting opening being closed by suture transversely to the long axis of the intestine. In certain cases the method of *invaginating or burying* the suspected area, of which we shall speak later on (see GANGRENOUS STRANGULATED HERNIA), may be employed. The cases in which these limited operations are applicable are, however, quite exceptional.

More frequently there will be found **an intestinal segment** of varying length, perforated at several points, black, flaccid, and fœtid: in a word, a dead segment, septic in the highest degree; if met with in the sac of a strangulated hernia, it might in an emergency simply be freely incised and drained, but when within the abdomen it must at all risks be **resected.**

This first point is indisputable, and the extent of the necessary excision, which is sometimes considerable, makes no difference. The danger does not lie in the length of intestine to be resected, and it is essential that the section should be made in healthy tissue at a sufficient distance from the gangrenous area.

Draw the affected loop outside, taking all proper precautions, if there are any perforations, to avoid inundating the peritoneal cavity with the intestinal contents: if necessary, the perforations may be temporarily closed by the application of pressure-forceps or clamps; isolate the intestine very carefully with a thick layer of gauze compresses, and perform the excision rapidly. Two intestinal clamps with the blades covered with drainage tubing are placed on the upper and lower ends, beyond the positions where the sections will be made; another pair of clamps, placed about an inch or so within the first pair, will guard against any leakage from the gangrenous segment; then a cut with the scissors between each pair of clamps divides the intestine. For the sake of expeditious working apply two long clamps outside the limits of the mesenteric triangle to be removed, cut the mesentery within the clamps, and remove the whole mass. The important point is to get rid of the septic gangrenous mass at once; then, after carefully cleansing the operation area and changing the protecting compresses, apply the necessary ligatures and proceed to deal with the cut ends of the intestine as the conditions may demand.

The method adopted must vary according to circumstances.

It must be recognized that **circular enterorrhaphy** is only rarely indicated; the mortality rates of the various statistics, even the most recent, demonstrate very plainly the great risk which is inseparable from any prolonged operation under the conditions we are considering. It would nevertheless be a mistake to make avoidance of circular enterorraphy a constant rule. If there is no peritonitis, if the intestine is not perforated, and one is in a position to perform intestinal suture quickly and well, it may be practised according to the technique described elsewhere (see PERFORATIONS AND RUPTURES OF THE INTESTINE). Difficulty sometimes arises—in a case of ileocolic intussusception for example—owing to the two ends being of unequal calibre; but there are several methods whereby this difficulty may be overcome.

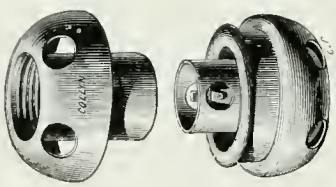

Fig. 394.—Murphy's button; its two halves separated

First, the ordinary dilated condition of the small end, which can be still further enlarged by an oblique section, may enable satisfactory adjustment with the colic end to be obtained.

Should the disparity be too great, the diameter of the large end may be reduced by suturing its two edges together for a certain extent, or again by excising a triangular area from the free border and then suturing its margins together.

The safest plan, however, is to close the large end completely by two rows of sutures and then to make a longitudinal opening about two inches higher up, to which to anastomose the small end. (See STRANGULATED HERNIA.)

The great disadvantage of all these operations is that they require time, no matter how much practice the surgeon may have had in abdominal

surgery. For that reason the various **anastomotic buttons**, of which Murphy's is the type (*Fig.* 394), are occasionally useful.

I cannot give a description of the numerous methods of suturing intestine with mechanical aids, nor of the various models of buttons and bobbins.[1]

Let it suffice that Murphy's button ought to figure in every surgical outfit, though at the same time, in my opinion, excluding certain exceptional indications, the day of all these mechanical methods of intestinal union is past.

Union by simple suture is the method which ought to be learned. Suture is the natural, simple, and truly surgical method—which always gives the greatest security and requires but little more time than the button methods. Without in the least wishing to exaggerate the accidents which may follow their use—secondary obstruction, delayed peritonitis from perforation, etc.—it is a mistake to think that time can always be saved by their employment, and it is impossible to leave such foreign bodies in the intestine without misgiving. Still, they remain useful in certain urgent conditions and in certain hands. The method of using these appliances—taking Murphy's button as the example—is as follows: The two halves are separated; each of them is mounted on a pair of forceps which will serve to hold it during the manipulations. A silk puckering thread is then passed around each of the two ends of the gut about an eighth of an inch from the edge. The introduction of the thread begins at the free border, it traverses the whole thickness of the wall from without into the interior of the bowel, then returns to the outside over the cut edge, to again pass through the wall from without; in this way the thread is carried all round the circumference of the cut end, until the free border is again reached. A half of the button held by the stem in the jaws of the forceps is now introduced into each end of the bowel (*Fig.* 395), the margin of which is then adjusted around the central stem of the button by gently tightening the puckering thread; when satisfactory adjustment has been obtained, the ends of the thread are knotted and cut short, and any unduly protruding portions of mucosa are snipped off with scissors. Now take hold of the two buttons through the wall of the bowel, holding them exactly in the axis of the intestine (*Fig.* 396); bring them together and introduce the one into the other (*Fig.* 397), and press them slowly home (*Fig.* 398). The last step is often difficult when the intestinal walls are thick and consequently not readily adjusted around the central stem. Close attention must be given to all the details before the two halves of the button are definitely pressed together. Lastly, it is sometimes advisable to introduce a continuous sero-serous suture uniting the circular folds on each side of the line of junction.

The button may be used to effect a lateral anastomosis as well as end-to-end union of intestine.

In the worst cases, where a perforated loop or a peritoneal cavity

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[1] See the study of the various types of buttons and of the methods of suturing with mechanical supports in TERRIER and BAUDOUIN, *La suture intestinale*, 1899.

flooded with fæcal matter and pus is found, nothing but the very simplest and most rapid procedures are justifiable; as a matter of fact, the vital

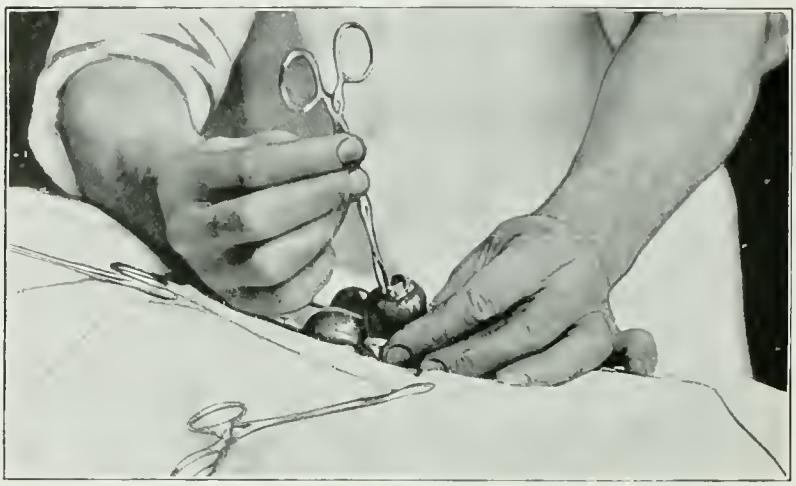

Fig. 395.—End-to-end union of intestine by Murphy's button. (1st step.) One of the portions of the button, held by forceps, is introduced into one of the intestinal ends, the wall of which is adjusted round the central tube by a puckering thread.

resistance is in these cases even more profoundly impaired than in the somewhat analogous traumatic ruptures of the intestine; here we have

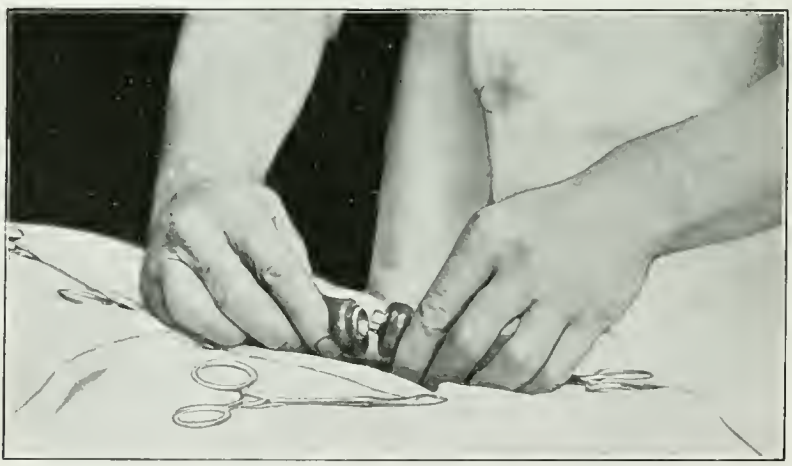

Fig. 396.—End-to-end union of intestine by Murphy's button. (2nd step.) Approximating the two halves of the button.

to take into account the long-continued septic poisoning which has preceded the gangrene and perforation of the strangulated loop.

Perform the resection as quickly as possible, **then fix the two ends in the wound.** This is the general rule, which practically works out as follows :—

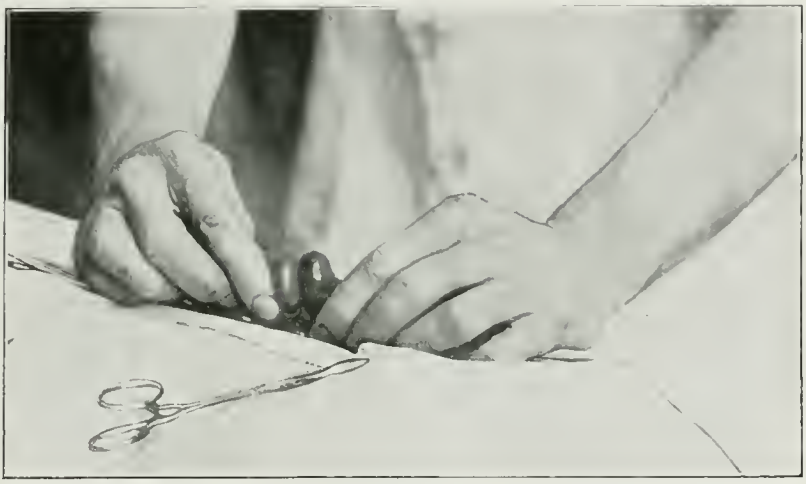

Fig. 397.—End-to-end union of intestine by Murphy's button. (3rd step.) Pressing the two halves of the button together.

The two ends of the intestine and the corresponding mesentery have just been divided ; ligature the vessels of any size in the cut edges of the mesentery, then unite the edges of the membrane by a rapid continuous

Fig. 398.—End-to-end union of intestine by Murphy's button. (4th step.) The two halves of the button are pressed home.

suture, beginning at the apex of the mesenteric resection and continued forward to the intestinal attachment. The two intestinal segments are in this manner approximated at their mesenteric borders ; some interrupted

seromuscular sutures are now introduced to unite them in the posterior thirds of their circumference, or in a still greater extent if time can be spared, and the remainder is sutured rapidly to the edges of the parietal wound. These open intestinal loops must always be placed at the inferior angle of the abdominal incision. The operation will be completed by free lavage of the peritoneum with warm boiled saline solution.

Lastly, the operator must be warned of other possibilities which may present themselves when the abdomen is opened. He may find : (*a*) *An adherent and inoperable cancerous mass ;* (*b*) *Peritonitis, either perforative or tuberculous.* (See later, PERITONITIS.)

Such discoveries imply errors of diagnosis, I admit ; but in so difficult a subject as intestinal obstruction, mistakes are sometimes unavoidable ; the possibility ought to be foreseen and guarded against, so that one may be in the position to make the best of the situation.

Instead of one of the ordinary forms of acute obstruction, there may be found a new growth, perhaps a cancer of the small intestine, still circumscribed and mobile, or an adherent ileocæcal cancer widely diffused into the mesentery, cancer situated in the pelvis or of the gall-bladder, etc., infiltrating and obstructing one or other portion of the intestine.

What is to be done ? Even in the cases where the anatomical conditions appear to be favourable for removal, it should only be undertaken if the patient's general condition is good. Usually, indeed, when the symptoms of obstruction are of some days' standing one must simply relieve them by means of an **artificial anus** or an **entero-anastomosis.** Of course, in the presence of a diffuse and adherent cancer, there can be no doubt as to the correct line of action. In a very large number of the cases an *artificial anus* will be the sole available resource, because it can be very quickly made. Undoubtedly, when the obstruction is situated high up, and when an enterostomy if performed must of necessity be on the upper part of the small intestine, the best plan is *to anastomose the loops above and below the seat of obstruction*, but it is always a rather delicate operation, one that requires some time, and in cases of obstruction it is rendered more difficult still by the distention of the upper end.

Be that as it may, the technique of entero-anastomosis is as follows : draw the entire affected segment outside the abdomen, or, if the tumour is fixed, at least *the loops above and below* ; determine first the position on each of the limbs at which the anastomosis is to be made ; it is essential that the two loops should come together easily, without traction and without any acute angulation. If the upper end is not too much distended, and if the intestinal wall is not too friable, the operation will be performed according to the technique already described (see PERFORATIONS AND RUPTURES OF THE INTESTINE) ; the intestinal contents will be displaced upwards and downwards, and the bowel secured on either side of the proposed anastomosis by means of clamps, rubber tubing, or gauze ligatures, which will serve to prevent leakage during the operation, and will only be removed when the union is complete.

This is undoubtedly the best plan, but it is not always applicable, and if the distention is great it is much better first of all *to incise and empty the intestine.* Protect the whole operation field with gauze compresses, leaving exposed only the area on the upper limb of the intestine where the incision is to be made; then make a longitudinal incision about two inches in length at the point selected, secure the mucosa at once with four pairs of Kocher's forceps, and allow the stream of fæcal matter to escape, directing it into a receptacle and assisting the flow if necessary by a little pressure on the rest of the abdomen; when the evacuation appears to be complete, or at any rate when nothing more comes, carefully cleanse the

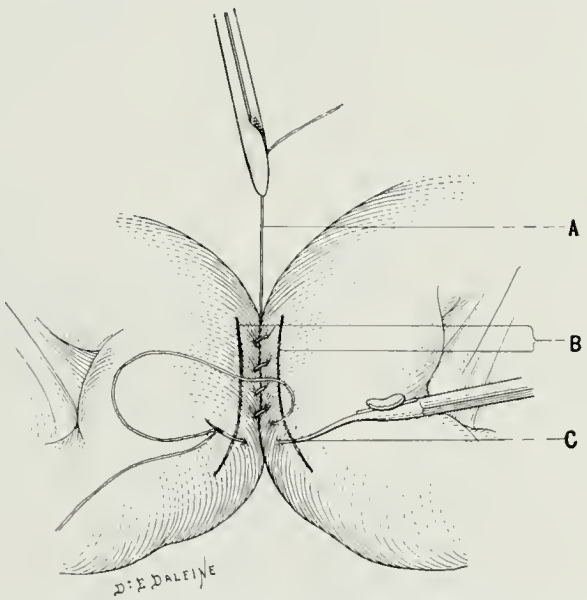

Fig. 399. Lateral entero-anastomosis. Joining the two loops together by the posterior continuous sero-serous suture; lines of the two incisions. (A) Initial end of the suture. (B) Lines of the two opposing incisions. (C) Needle continuing the posterior suture. (For the subsequent stages of the operation, see *Figures* 289 and 290.)

lips of the incision and the exposed portion of the loop, change the soiled compresses, cover up the segment which has just been opened and emptied, and give it into the charge of an assistant, while one looks for and brings out the lower segment, which will be opened and emptied in its turn and in the same manner.

There are now seen two parallel loops and two opposing orifices (*Fig.* 400); they will be united in exactly the same manner as in performing circular enterorrhaphy. First unite the two posterior borders by a continuous seromuscular suture; this first suture is the most difficult, and in order to execute it the two loops may be inverted from below upwards, so that the posterior surfaces are towards the operator (*Fig.* 401); it will often be found better to work from before backwards, turning the

posterior lips of the intestinal incisions outwards with forceps, so exposing the serous coats for the passage of the suture. The two ends of the thread are left long above and below, to be used afterwards to complete the anterior half of the seromuscular suture.

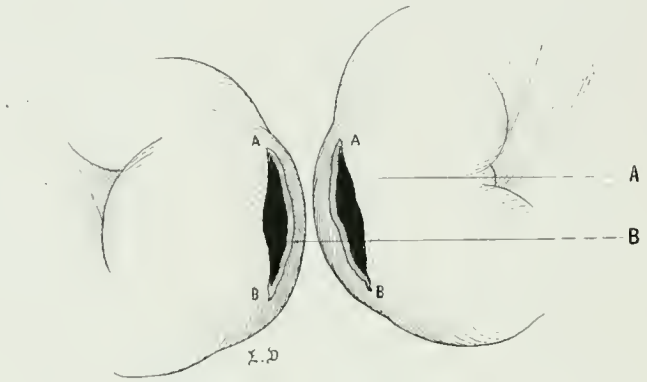

Fig. 400.—Entero-anastomosis after preliminary incision. The two parallel loops and the two opposing orifices. (AB, AB) The two longitudinal incisions. (A) Anterior lip. (B) Posterior lip.

The second step consists in uniting the posterior margins by a second continuous suture which includes the whole thickness of the walls in its loops, and is continued round the lower angle of the incisions and along the anterior margins to terminate at its starting-point at the upper angle

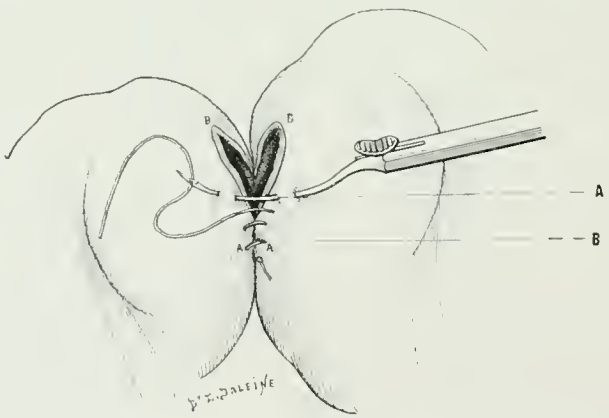

Fig. 401.—Entero-anastomosis after preliminary incision. Suturing the two posterior lips, with the two loops of bowel inverted. (AB, AB) The two longitudinal incisions. (A) Posterior half of the continuous sero-serous suture. (B) Beginning of the suture.

(*Fig.* 402). It only then remains to complete the anterior half of the seromuscular suture.

The anastomosis may of conrse be made with the aid of a button, but as before stated, suture is the method of choice. If the obstructing growth

is situated on the large intestine, it may be necessary to unite the ascending with the transverse colon, in the case of a growth at the hepatic flexure;

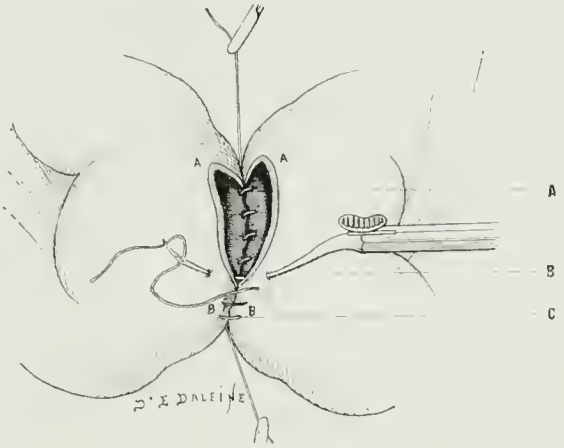

Fig. 402.—Entero-anastomosis after preliminary incision. The two posterior lips are united. Continuation of the inner suture on the two anterior lips; above and below are seen the two ends of the sero-serous suture, which will be employed immediately to complete the anterior half of the suture. (AB, AB) The two longitudinal openings. (A) Posterior line of union. (B) Anterior half of the inner suture. (C) Point where the posterior half of the inner suture becomes continuous with the anterior half.

or the transverse colon to the descending colon, in the case of a growth at the splenic flexure; but generally speaking, an anastomosis between

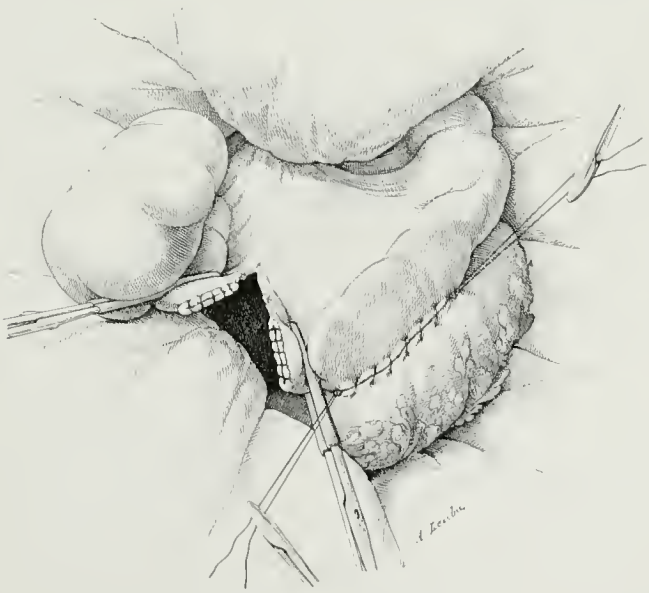

Fig. 403.—Ileo-sigmoidostomy.

the terminal part of the ileum and the sigmoid colon or the upper part of the rectum is the best and safest procedure. *Fig.* 403 shows the operation

of ileo-sigmoidostomy completed, and after the description which we have just given of entero-anastomosis the technique adopted can be readily followed. The ileum is divided between two pairs of forceps a few inches from its cæcal termination, and the two ends are closed; then the terminal loop of the small intestine is placed in contact with the sigmoid colon, and the two segments are united by lateral anastomosis. The clamps are then removed, and after ligature of the divided vessels the cut edges of the mesentery are united by a few points of suture.

This again is not a task for one who has not had much experience of abdominal surgery, and unless the operator has at least repeatedly performed the operation on the dead subject, he will be well advised not to attempt it.

ENTEROSTOMY AND ARTIFICIAL ANUS.

As already shown, it is necessary to preserve a clear distinction between these two methods of **intestinal drainage.**

When the symptoms are definitely due to an inoperable cancerous obstruction of the lower portions of the intestine, a cancer of the rectum or of the sigmoid colon for instance, or again to a cancer situated at a higher level in the alimentary tract, but to which, for any reasons, entero-anastomosis is inapplicable; in a word, when the drainage opening to be made above the obstruction must be permanent, then certain conditions necessarily associated with that permanence must be kept in view, and the operation performed in such a manner that, while providing for free escape of intestinal contents from the upper end, their passage into the lower segment is prevented, that is to say, **an artificial anus** must be made with as complete a spur as possible.

The object of an **enterostomy** is, however, quite different; it is essentially a means of temporary drainage by means of a provisional channel which will subsequently be closed, and the operation must be adapted to meet these requirements. Under these conditions, and when properly performed, enterostomy will always be a valuable resource in certain urgent situations where laparotomy, the method of choice, is impracticable even when the impracticability depends not on absolute but on comparative reasons, such as the surroundings, inadequate assistance, or lack of equipment or experience.

Enterostomy and the operation for artificial anus must, therefore, be included in the list of operations which every practitioner should be able to do and which he ought to undertake when necessary.

ENTEROSTOMY.

This operation may be practised on any of the intestinal segments: the sigmoid colon, transverse colon, cæcum, or small intestine. Usually **the abdominal wall is incised in the right iliac fossa, and the first**

distended loop of intestine which presents itself is taken. This is the general rule, and is worth elaborating.

Here is a patient with a uniformly distended abdomen, on whom, for reasons already discussed, it has been decided to perform Nélaton's enterostomy forthwith. In the right iliac fossa, about two fingers' breadth internal to the anterior superior iliac spine, make a slightly curved incision about 4 inches long, with its centre opposite that spine; incise the skin, the subcutaneous fatty tissue, in which the application of forceps will be needed to some small arteries (usually two), the white aponeurosis of the external oblique, and then the subjacent muscular layer; divide the muscular fibres carefully in several cuts until the retracting fibres expose beneath them the yellowish-white surface of the transversalis fascia.

Lay aside the scalpel and take the scissors and dissecting forceps: with the latter pick up a fold of the fibrous sheet and divide it; sometimes the same cut will enter the peritoneal cavity, and by the little opening some reddish fluid will escape and the smooth rounded surface of the intestine will be seen; at other times only the fascia will be cut, and it will be necessary to pick up the underlying layer, the parietal peritoneum. Make sure that the fold is empty, and open it with the points of the scissors. The close application of the distended intestine to the deep surface of the abdominal wall renders these precautions necessary. Enlarge the opening in the peritoneum a little, and on the left index finger (the best director), which pushes back the intestine and raises the membrane, extend the incision to the extremities of the superficial wound. At once secure the peritoneal edges with a few pairs of forceps and arrange an aseptic compress over the presenting loops which tend to escape from the wound. Take advantage of this incision to glance into the abdominal cavity, or, better, to make a *rapid digital exploration*. The character of the escaping fluid and the appearance of the presenting loops of intestine will show if there is any peritonitis, and will give some idea as to the gravity of the intestinal lesions: by means of the finger insinuated gently into the iliac fossa, into the pelvis, towards the sacral promontory, and into the sub-umbilical region, useful information may be sometimes obtained regarding the cause of the obstruction; one may feel a tumour or a mass of twisted coils, etc., perhaps may even be able to draw the obstacle into the wound, and so transform an operation primarily undertaken as a palliative measure into a radical one. It is impossible, however, to rely on this, and much time must not be occupied over the intra-abdominal examination, which at the best can only be very incomplete because of the limited access provided by the lateral incision. But there are some fortunate chances which it would be a pity to miss through not devoting to it the few minutes necessary for this cursory examination.[1]

[1] In proof of this I here quote a very curious case of Albarran's. A woman, 66 years of age, was attacked with very severe intestinal obstruction, which because of a history of repeated attacks of biliary colic, it was thought might be due to the impaction of a gall-stone. As the patient's condition was very bad, Albarran did not venture to perform an exploratory laparotomy, but opened the abdomen in the right iliac fossa at the point of maximum pain with the intention of performing enterostomy. He therefore made "a small incision in the abdominal

Look for the cæcum: it must not only be felt but seen; slip an aseptic compress under the upper lip of the wound, spread it over the presenting loops of small intestine, push them inwards, and thus expose the right iliac fossa. If the cæcum is dilated, draw a portion of its wall into the wound, and on it perform the enterostomy; if it is collapsed and empty, the obstacle is situated higher up at some point in the small intestine, and, before taking by chance any one of the presenting loops, if the local conditions permit and time is not too pressing, look for the end of the ileum and endeavour to follow it up to the seat of obstruction.

But here again one cannot depend on being able to carry such an undertaking to a satisfactory conclusion: if any difficulty is encountered, do not persist. Such an indirect laparotomy by an inadequate lateral incision may easily become more dangerous than the free median exploration which it was undertaken to avoid. Therefore take advantage of any fortunate chance if it presents itself; if not, do not delay, but **take one of the distended loops of small intestine which lie close at hand.**

Bring the loop into the central part of the wound, and on either side pack a fold of gauze into the peritoneal cavity to retain the rest of the intestines. A small area of the convexity of the loop, an inch in diameter, must first be fixed to the abdominal wall; then open the gut within that area and attach the margins of the opening to the skin; we now have a small fæcal fistula without a spur and without any angulation of the loop.

Introduce the *fixation sutures* of fine silk in the following manner (*Plate VIII*): each thread is passed first of all longitudinally in the wall of the intestine, well into the thickness of the muscular coat, and includes in its grip a bridge of tissue about a third of an inch wide; this forms the middle part of the loop; then the needle traverses the external aponeurosis, the muscular layer, and the peritoneum, on the corresponding lip of the parietal wound, and draws the ends of the suture through to be knotted together superficial to the aponeurosis. Each of the sutures is thus passed in three stages, but the few extra seconds occupied in doing this are more than balanced by the additional security.

Generally four sutures are sufficient, but six are preferable; two to the right, two to the left, and two commissural points, one above and one below. I need scarcely say that the introduction of the sutures in the thickness of the intestinal wall demands a good deal of care. A sharp, fine needle and a fine thread which works easily in the eye of the

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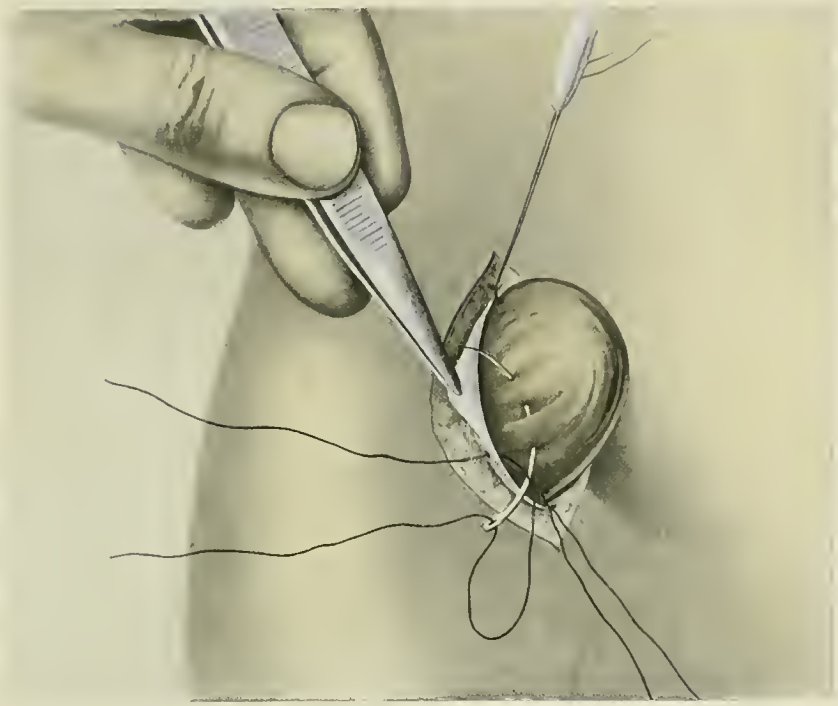
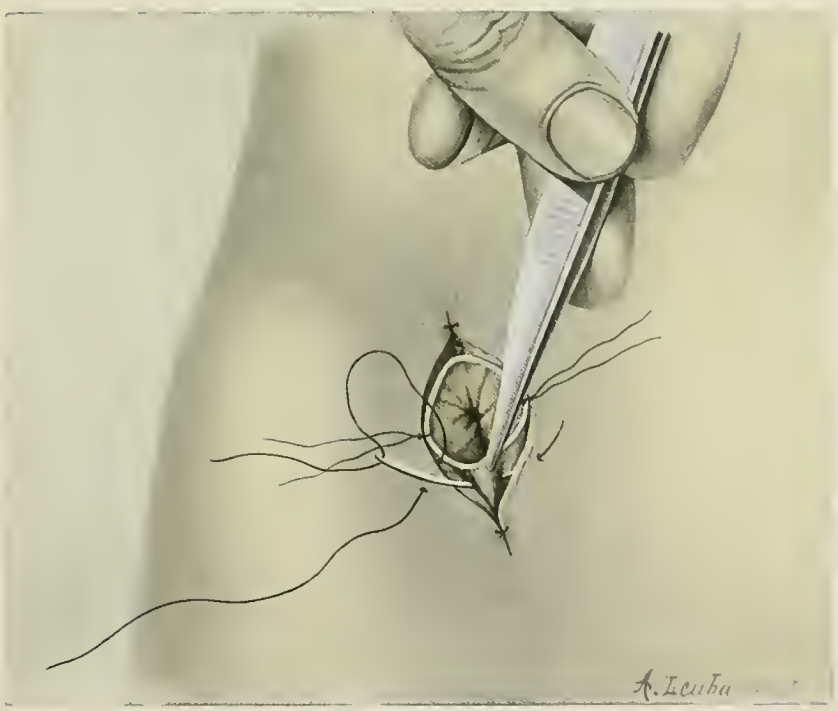
wall, and on introducing a finger into the peritoneal cavity to draw out one of the distended loops, he felt a large hard mass in the interior of the loop. This loop was brought outside and incised, and a large gall-stone, the size of a hen's egg, was discovered and removed; the intestinal incision was sutured and the abdomen closed; the whole operation had not lasted twenty minutes." (Thèse de Garin, already quoted, obs. ii., p. 34.)

Plate VIII.—Enterostomy. On the upper figure the two commissural sutures have been knotted; a lateral suture is being introduced. In the lower figure is shown the suturing of the edges of the opening in the intestine to the skin.





ENTEROSTOMY

needle, are required; the thread must be drawn through parallel to the surface of the intestine, in order to minimize the risk of tearing the friable wall.

Once the intestine has been properly fixed, the rest of the operation is quite simple, and can be quickly terminated. First suture the musculo-aponeurotic layers of the parietal wound above and below the gut, either by some interrupted sutures, or better by a continuous suture; suture also the extremities of the skin wound. Then open the intestine with the scalpel or scissors, after having packed gauze all around; allow the first discharge of fæcal matter and gas to escape, then sponge the parts clean, and picking up the edges of the intestinal opening with forceps, attach them to the margins of the skin wound by a few interrupted sutures on each side, and put in a commissural suture above and below, as shown in *Plate VIII.*

The operation is finished; put no drainage tube or cannula in the intestinal orifice, but simply let the contents escape; the evacuation may be assisted by gentle pressure on the abdomen. The operation will not always be immediately followed by a large discharge of intestinal contents; the intestine has lost its contractility, and the drainage is at first quite mechanical, if I may use the expression; often it will not be until some hours later, when the intestinal tonicity is returning, that any considerable quantity will escape. It is a good practice to cover the wound above and below the fistula at once with a strip of gauze fixed with collodion, which will protect it to a certain extent from contact with fæcal matter. I need scarcely emphasize the necessity for minute cleanliness in the after-treatment.[1]

If the patient survives, various possibilities may develop:—

1. **The normal course of the intestinal contents is not re-established,** and an examination of the abdomen after the urgent symptoms of obstruction have subsided discovers an irremovable obstacle; the fæcal fistula then remains permanent.

2. **The normal course of the intestinal contents is not re-established, but by a secondary operation it is possible to remove the obstruction,** and at the same time, or at a subsequent operation, the fæcal fistula is closed.

3. At the end of some days **the bowels begin to move naturally,** and the discharge by the natural passage becomes more and more abundant, while at the same time the leakage from the fistula becomes progressively less; the fistula may then close spontaneously, but often a secondary operation is necessary which is, however, comparatively simple and generally successful.

[1] Fæcal fluid which has remained stagnant for some time in the occluded intestine possesses exceedingly septic and irritating properties: it quickly causes ulceration of the tissues around the opening, and if the muco-cutaneous adjustment has not been sufficiently exact, and if care is not taken to protect the wound and the surrounding area with vaseline, the ulceration may even extend to the peritoneum.

ARTIFICIAL ANUS.

This operation may be practised on any segment of the intestine ; the place of election is, however, the sigmoid colon, and the incision is made over the left iliac fossa.

This incision is symmetrical with that which we have just mentioned when speaking of enterostomy ; that is to say, it is about 4 inches long, slightly curved, and placed with its centre about two finger breadths internal to the left anterosuperior iliac spine. The division of the abdominal wall demands the same precautions.[1]

When the abdomen is opened, it is always advisable to begin by *a rapid examination of the cavity*, or at least of the zone which is easily accessible ; *then seek for the sigmoid colon.* I say " seek " advisedly, for though a distended sigmoid may present itself between the lips of the wound as soon as the peritoneum is opened, it is far from being a constant occurrence, particularly when the distention is great ; then loops of small intestine appear first, and they must be displaced under a compress before the sigmoid colon can be discovered and brought outside.

Verneuil long ago pointed out that when the sigmoid is not found immediately after opening the abdomen, it must be sought for *in an inward direction, towards the sacro-iliac synchondrosis* or *towards the sacral promontory.* It will be recognized by its sacculations, longitudinal bands, and fatty appendices epiploicæ.

Seize it gently between the fingers and draw it outwards ; sometimes it is adherent, fixed by a diffuse new growth, and it is necessary to go a little higher up to find a healthy and mobile portion. In any case, when it has been found, it is necessary to make sure by sight and touch that the area on which the operation is to be performed is free from disease.

1. **Operation in Two Stages** (The Maydl-Reclus operation).— If the situation does not appear to be too urgent, if it is not imperative at once to relieve the intestines of their septic contents, the following plan will be the simplest : Draw a loop outside the wound ; pass through its mesentery a straight rod of any kind, such as the end of an aseptic gum catheter, or a glass rod, etc., which, bridging across the wound, rests on the abdominal wall on either side, forms a support for the bowel, and prevents it from slipping back into the abdominal cavity (*Fig.* 404) ; reduce any excess of the loop above and below the support, and bring the extremities of the parietal wound together by a few interrupted sutures. For the supporting rod, a bridge of skin may be substituted, by making an

[1] When there is no great urgency, as for instance when the operation is being performed for symptoms of chronic obstruction due to a rectal cancer, instead of dividing the muscles of the abdominal wall, they may be split in the manner recommended by Hartmann : after the skin has been incised the fibres of the aponeurosis of the external oblique are separated with a director, and a retractor placed on each of the lips ; the fibres of the internal oblique and transversalis are dissociated in the same way and drawn apart by other retractors ; it then only remains to open the peritoneum. (H. Hartmann, " Technique de la colostomie." *Revue de chir.*, 10 nov., 1900, no. 11, p. 613.)

incision as shown in *Fig.* 405; the mesocolon is perforated between two vessels with a blunt instrument, and the small cutaneous flap is passed through the opening and sutured to the other skin edge.[1]

This finishes the first step of the operation; apply an aseptic dressing, and at the end of forty-eight hours the bowel may be opened on its convex surface with the thermo-cautery. Quite often in chronic cases the simple fixation of the loop is followed by a marked remission of symptoms,[2] and in consequence, a sufficient time to insure the formation of protective adhesions may be allowed to elapse before completing the operation.

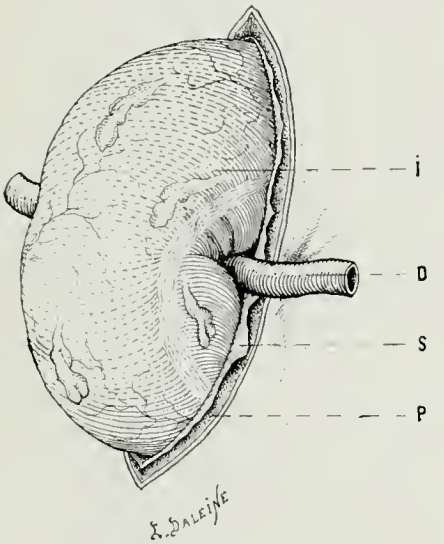


Fig. 404.—Artificial anus: operation in two stages. The loop is maintained outside by the end of a gum catheter passed through the mesocolon. (I) Sigmoid colon. (D) Aseptic gum catheter passed through the mesocolon. (S) Parietal peritoneum. (P) Edge of abdominal incision.

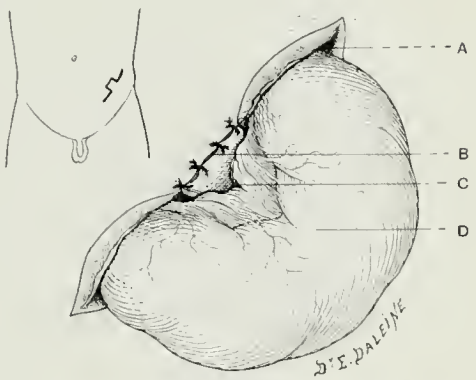


Fig. 405.—Artificial anus: operation in two stages; the Audry-Jeannel method. The loop is maintained outside by a bridge of skin passed through the mesocolon. On the left, a diagrammatic representation of the skin incision. (A) Upper angle of the incision. (B) Bridge of skin passed through the meseutery and sutured to the opposite edge of the wound. (C) Mesocolon perforated to give passage to the bridge of skin. (D) Loop of intestine.

The application of the two-stage operation is considerably limited, in urgent conditions, by the necessity for a longer or shorter delay in opening the bowel. Usually, when obstruction is complete and the symptoms of septic poisoning are serious, **it is imperative to provide an immediate exit for the stagnant intestinal contents**; under such circumstances the method of choice will be the following :—

2. **Operation in One Stage.**—Make the iliac incision as before; secure the peritoneal edges with forceps, seek for the sigmoid colon, and

[1] This is the Audry-Jeannel method. (AUDRY, "Un nouveau procédé de colostomie iliaque; colostomie transpariétale," *Arch. prov. de chir.*, 1892, t. I., no. 4, p. 347.—JEANNEL, "De la colostomie iliaque d'après le procédé d'Audry," *Arch. prov. de chir.*, 1894, t. iii., no. 2, p. 96.)

[2] In some cases of pseudo-ileus, the mere evisceration of the loop has been followed by a sudden cessation of the symptoms and spontaneous action of the bowels. I have quoted an instance of this.

draw a complete loop, with its mesocolon, into the wound. This loop will be united to the parietal peritoneum and the musculo-aponeurotic wall by a circle of U-sutures (*Fig.* 406); one of the sutures on each side should include the mesocolon, as shown in *Fig.* 407;[1] these lateral sutures are passed through the whole thickness of the abdominal walls, are knotted on the surface of the skin, and insure the formation of an efficient spur which will prevent the passage of any of the intestinal contents into the distal limb of the loop.[2] The sutures may be passed at right angles to the longitudinal axis of the intestine and to the edges of the wound; but when introduced in that way they have a great tendency to cut out, no matter how carefully they are tied, and further, the intestino-parietal junction is never continuous and regular.

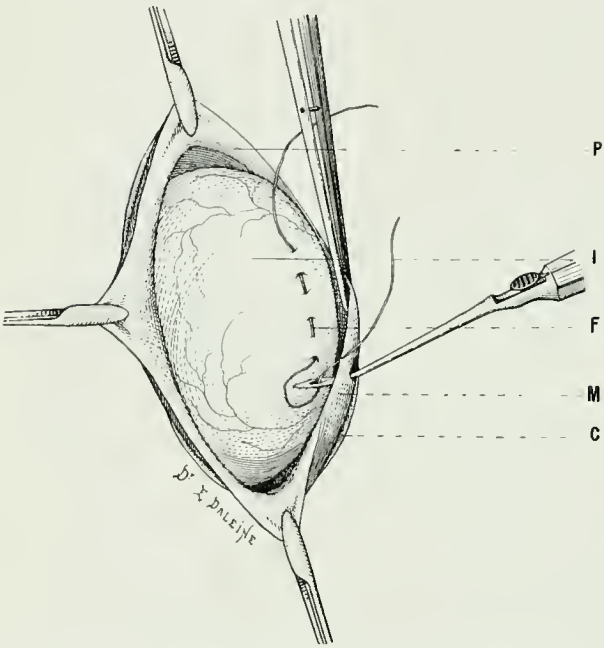


Fig. 406.—Artificial anus: operation in one stage. Passing the fixation sutures. (P) Parietal peritoneum. (I) Sigmoid colon. (F) Thread in the muscular wall of the intestine; several loops have been passed by one movement of the needle; each separate loop will be drawn through the abdominal wall, divided, and the corresponding ends of adjacent loops knotted together. (M) Muscles of the abdominal wall. (C) Skin.

For this two-fold reason it is better to employ the U-sutures, the central part of the loop passing in and out in the thickness of the sero-muscular coat parallel to the long axis of the intestine, and the ends, after traversing the whole thickness of the abdominal wall with the exception of the skin, are tied on the surface of the external oblique aponeurosis (*Fig.* 406).

If necessary, the extremities of the wound are closed by one or two sutures, then the bowel is opened longitudinally with the knife or thermo-cautery, or an oval segment of the most prominent part of the convexity

[1] In this way the two limbs of the loop are joined together like the two barrels of a gun.

[2] I am speaking of those cases in which the nature of the obstruction is known (inoperable cancer, etc.) and demands the formation of a permanent artificial anus. In other cases the colostomy ought always to be performed in the same manner as the enterostomy already described: that is to say, by fixing to the abdominal wall a relatively small area of the circumference of the intestine, and by making an opening sufficient for drainage, but such that its subsequent closure will be easy. It will then be advisable not to bring a whole loop outside the abdomen, and to introduce the U-sutures at some distance from the mesocolic attachment.

may even be excised, and the margins of the opening are immediately attached to the skin by a few interrupted catgut sutures. No tube of any kind is placed in the intestine.

Lastly, an **unduly large opening in the bowel** is to be avoided; it is quite unnecessary for satisfactory drainage of the intestine, and it adds considerably to the risk of subsequent prolapse.

APPENDICITIS.

Let us first lay down the following rule: **every case of acute appendicitis ought to be operated on; the date alone of the operation may vary; in a certain number of cases it must be performed during the attack, but as often as possible during a quiescent stage.**[1]

The advantages of the "interval" operation are indisputable: the risks are small; it is complete, because it always permits a search for and the removal of the appendix; and it insures permanent recovery with the minimum of danger. That there is therefore a great benefit to be gained by waiting in order to be able to intervene during a quiescent period will scarcely be disputed. Further, experience has shown that under the early and rigorous application of *the treatment by immobilization*, a considerable proportion of the cases of acute appendicitis subside, become localized, lose their alarming initial characters, and finally resolve and permit the necessary operation to be deferred to the most favourable time.

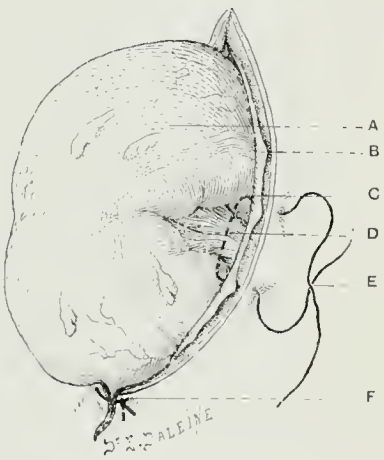


Fig. 407.—Artificial anus, operation in one stage. Lateral suture, including the mesocolon and bringing the two limbs of the loop together. (A) Sigmoid colon. (B) Parietal peritoneum. (C) Lateral suture, the loop including the mesocolon. (D) Plicated mesocolon. (E) Knotting on the skin the two ends of the lateral suture. (F) Inferior commissural suture.

Every case of acute appendicitis is not, however, amenable to this treatment; after a very short time the march of symptoms may indicate the necessity for immediate operative intervention.

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[1] This doctrine does not apply to appendicitis alone. We do not operate on a case of acute salpingitis at the height of a febrile crisis, with active pelvic peritonitis. Certainly not; and even when dealing with a large pyosalpinx, if the symptoms become urgent we prefer in the first place to perform a temporary palliative operation by simply opening and evacuating the accumulation of pus by way of the vagina (see COLPOTOMY), reserving the complete radical operation to a later date, when the acute symptoms have subsided. We do the same in appendicitis which, localized to the iliac fossa by adhesions, is excluded from the general peritoneal cavity, like a tube at the bottom of the pelvis. However, it must be admitted that in appendicitis the danger is somewhat graver than in the parallel case, because of the risk of gangrenous processes and perforation which often occur unexpectedly, and the supervision must therefore be even more rigid.

Nor are all cases of acute appendicitis from the outset submitted to this treatment, which has nothing in common with ordinary expectant treatment, still less with those aggressive and harmful measures which are so hard to uproot; often when we see the patient the disease is already in an advanced stage, and its evolution cannot be influenced by any indirect measures.

In the following pages we shall endeavour to show how, in our opinion, the varying clinical situations should be met; in conformity with our method we shall not pile up statistics nor strive after any definite classification, which must always be of necessity more or less artificial. We shall present illustrative cases and, face to face with the reality and our responsibilities, we shall ask ourselves what should be done.

I. **The Patient is seen within a few Hours of the first appearance of Symptoms.** In other words, one has the complete control and also the entire responsibility of the treatment from the beginning.

If the diagnosis is perfectly clear,[1] and if the "external" conditions are favourable, immediate operation is indicated; when performed during the first twenty-four or thirty-six hours, routine operation is a perfectly rational procedure; the prognosis will generally be good (statistics prove it), the operation itself will be simple and radical, because the appendix, being still free, will be easily found and removed; it will also forestall all the evil possibilities of the unknown evolution of the attack.

Practically, however, it must be admitted that such a line of action often meets with unsurmountable obstacles.

If that is so, then institute forthwith what I have spoken of as the **treatment by immobilization,** and which has been so well formulated by Jalaguier. General immobilization of the body, in the dorsal position, and immobilization of the intestines—these are indeed the essential factors in rational treatment, and our only means of influencing the progress of the disease.

There must be no transportation or moving about of the patient; keep him quietly in bed on his back. *Give no purgatives or enemata.* Give nothing by the mouth, no beef-tea, no milk, nothing; a few drops of Vichy water or boiled water on the tongue to allay the thirst, at the most a teaspoonful of Vichy water every two hours, and that is all.

Continuous application of ice to the abdomen: not in a little bag applied haphazard and slipping about every moment, but in two or three large rubber bags, containing broken ice, duly changed as the ice melts, covering the iliac fossæ and the central part of the abdomen.[2]

[1] It is by no means always so at this stage. "If I had been an advocate of immediate operation," writes Jalaguier, "I should have operated on two cases of typhoid fever, two cases of colicky enterocolitis, one case of renal colic, and possibly even in a case of right-sided pneumonia." Further, though it is very desirable that the surgeon should be called in on the first appearance of symptoms of appendicitis, in practice the difficulties in the way of such a line of action are often very great.

[2] Continuous application of ice is the best means of relieving the pain; however, if the patient is very restless, small doses of opium may be administered ($\frac{1}{6}$-gr. every three or four hours), but the opium or morphine must not be abused; it may act harmfully on the kidneys, and it also masks the abdominal symptoms.

Be very chary with local examinations; make them with the ends of the fingers and with the greatest possible gentleness; refrain from frequent repetitions; at this initial stage, once the diagnosis is made very little is to be learnt from them; it is to the general condition, the pulse, temperature, and abdominal symptoms, that one must look for information.

Close supervision is a very important feature in this treatment. The method must be carried out in its entirety from the first; add nothing to it, take nothing away; never be content with a modified form of it; *it is a definite method of treatment*, and as such it must be strictly applied if it is to be efficacious. We have already said that the period of doubt is short, and in twenty-four hours at a minimum, five to six days at a maximum, one will feel confident as to the probable course of events.

Under the immobilization treatment strictly applied from the beginning, the following developments may be observed.

(*a*). Some *painful but transitory* forms which correspond closely to the appendicular colic of Talamon yield very quickly, sometimes indeed suddenly; do not therefore be over-influenced by the initial severity of the pain.

Case 31.—A little boy, 12 years of age and in good health, had been taken ill the previous day with acute pain in the right iliac region; the pain had remained the outstanding symptom; it had prevented sleep and had caused great restlessness and fatigue, which was indicated by the child's pale and weary face. There had been only one vomit, which had consisted of food-stuff. The pulse was rather fast but of good quality; the temperature had not exceeded 99·4°. The abdomen was not distended, and was resonant in its whole extent including the right iliac fossa; in the latter region the slightest pressure revealed very acute tenderness, particularly at McBurney's point. The absence of any fever, or of any abdominal symptoms beyond the pain and tenderness in the right iliac fossa, and the absence of all signs of septic absorption, negatived any idea of immediate operation. With absolutely restricted diet, the application of ice, and the administration of a little opium, the pain ceased at the end of twenty-four hours and all the symptoms disappeared, without leaving any appreciable trace even in the appendix region.

The pain at times may *from its great severity be exceedingly disconcerting*.

Case 32.—I was summoned one evening to see a patient, a young woman 25 years of age, who had been crying out with pain since the morning, and was in consequence in a condition of nervous excitability, with an alteration of face and a disturbance of the pulse which at first sight were very deceptive. The pain very definitely occupied the appendix region; it had begun very suddenly and radiated to the rest of the abdomen, while preserving its original point of maximum intensity. A diagnosis of an acute perforating appendicitis had been made, and the patient had been sent to hospital with a view to immediate operation.

But the abdomen was not at all distended, there had been no vomiting, the pulse though fast was very good, the temperature was only 98·6°, the tongue was moist, and the facies did not indicate septic absorption. In a few hours the pain had considerably diminished, and palpation of the iliac region, which then became easy, gave entirely negative results. With opium and ice, by the next day all the symptoms had disappeared, except that at McBurney's point quite definite tenderness indicated clearly the nature of the trouble.

I have on many occasions seen these alarming onsets followed by

very rapid disappearance of symptoms: therefore, though the pain with its sudden onset and special localization is one of the most important diagnostic factors, it cannot in itself be considered as an indication for immediate operation if the general and other local symptoms are not in keeping with it.[1]

(*b*). At other times the onset is characterized by a sudden rise of temperature (101°–102°), vomiting, and pain in the iliac fossa; but the pulse is strong, full, and of average frequency; the abdomen is only tender in the iliac region, and the facies is good; on the second or third day the temperature falls abruptly to normal. The iliac pain may persist for some time longer without any swelling appearing, often indeed without anything appreciable on palpation.

(*c*). The ordinary acute appendicitis persists for a longer time, and even in favourable cases—submitted to treatment by immobilization from the beginning, and which ultimately subside—the fever and other symptoms only diminish gradually, and there is a period of doubt and sometimes very great anxiety.

In the favourable cases of which I am speaking, the pain and abdominal distention become localized more or less quickly to the iliac region, the vomiting becomes less frequent and ceases, the pulse remains full, regular, and does not go beyond 100 to 110, preserves a normal ratio to the temperature (101°–103°), and follows it in its daily oscillations.

Constipation is, and remains, usually complete:[2] neither fæces nor flatus are passed. This is not a complication; it is an ordinary symptom, which requires no special measures and which yields spontaneously when the acute crisis is over. The passage of flatus thus constitutes a favourable sign.

On the second, third, or fourth day a thickening is discovered in the right iliac fossa, a diffuse induration, hard and thick, which appears to be continuous with the abdominal wall. This thickening indicates a process of localization, and shows that a barrier of adhesions is forming and extending around the focus of infection; it is therefore a favourable sign. Towards the fifth or sixth day the temperature begins to come down and falls more or less quickly to normal, the pulse-rate slackens parallel with the fall of temperature, and the constipation ceases; the swelling, which by this time has sometimes extended over a considerable area, no longer increases; it begins to disappear, and the abdominal wall to relax at its periphery, while still preserving its central hardness, and it becomes less and less tender on palpation.

At this critical stage of the illness watchfulness is too often relaxed; purgatives are administered, or, yielding to the patient's entreaties, feeding is begun too soon. A large number of relapses are really due to these causes, though they are deliberately ascribed to the passive character of the preceding treatment.

[1] Rapid diffusion of the pain, however, after the first twenty-four hours, along the ascending colon and to the left below the umbilicus, is always an important sign, and points to a grave toxic form complicated by early infection of the mesenteric glands (Quénu).

[2] Diarrhœa occurs in some cases of appendicitis; sometimes it is very profuse and indicates a hypertoxic form of the disease which requires immediate operation.

I cannot do better than quote Jalaguier's rules: The first cup of milk must not be given until twenty-four hours after the temperature has fallen to normal, and an exclusively milk diet must be continued until the end of the second week. The first dose of opening medicine (castor oil or calomel) will not be administered until twenty-four or thirty-six hours after the end of the crisis, and there must be no further purging in the following days, regular action of the bowels being insured by milder methods: gentle laxatives, suppositories, or enemata.

The use of the ice-bag should not be discontinued for several days after defervescence; finally, the patient will be kept in bed till the end of the third or fourth week.

That does not complete the cure, however; it is only the end of the first stage. The second stage consists in the removal of the appendix during the quiescent period; the operation should not follow immediately, or some days after the subsidence of the acute symptoms, to merit its title of interval operation,—a delay of two or three weeks in the milder cases, and of at least six weeks after a severe attack, is necessary.

These are the outlines of the method of treating acute appendicitis by "delayed operation." It is the best method, when it is thoroughly understood and properly applied. Rigid supervision, we repeat, is an essential feature; when such supervision, by reason of distance or place, etc., is not possible, the risks become too serious, and *immediate operation is the more prudent course.*

Further, it is necessary to hold oneself in readiness to operate at any stage or at any hour of the acute attack; if doubt arises, if the course of the illness ceases to be unreservedly benign, **the doubt in itself constitutes an indication for immediate operation.**

Under these conditions alone is the method justifiable. Even when the treatment by immobilization is instituted from the beginning and carefully followed, the course of the disease is often very different from that which we have just outlined.

(*A*). From the first twenty-four or thirty-six hours, the rapid aggravation of the symptoms, the disagreement between pulse and temperature, the restlessness, the pinched face and abdominal distention, all indicate a **severe and excessively toxic attack.**

Case 33.—A little girl, 13 years of age, was taken suddenly ill after breakfast on Sunday with acute pain on the right side of the abdomen. She went to bed, vomited a little, and some hours later the doctor who was called in discovered a very definite painful spot in the right iliac region, a slight degree of diffuse tenderness of the abdomen, and a temperature of 100·4°. Next day the general and local conditions were practically the same, but in the evening the thermometer showed 102·2°; the abdomen was a little distended, but there was no vomiting. A restless night was passed. On Tuesday morning the temperature was 100·4°, still no vomiting, but the pulse was 125, the face a little drawn and anxious. The abdomen was distended and very tender over its whole surface: in the right iliac region the wall contracted and hardened on the slightest touch; to percussion there was a slight diminution of resonance;

at McBurney's point the pain was extremely acute, and although pressure was painful over the whole of the abdomen, at that particular spot it was intolerable.

Operation was decided upon and performed some hours later. Under chloroform, iliac palpation gave no further information; there was no swelling: at the most a trace of thickening.

I incised the abdominal wall and peritoneum. Three or four tablespoonfuls of turbid fluid escaped, and I came down on the outer surface of the cæcum; behind it I felt and exposed the appendix. It was embedded in shreds of purulent lymph and surrounded by a little pus. I freed the organ and brought it out and, after ligating the base with catgut, resected it with the thermo-cautery. *It was gangrenous and perforated at the tip.* I then explored the latero-cæcal area, and found it covered with purulent lymph and in free communication with the general peritoneal cavity; on the cæcum and on the surface of the neighbouring coils of small intestine there was the same purulent coating. I cleansed the area with gauze swabs; the wall of the cæcum was very friable, and bled on the slightest touch. However, although there were no limiting adhesions, the septic focus did not appear to extend far beyond the iliac region. A drainage tube was placed to the outer side of the cæcum, and the wound partially closed.

Although there were no symptoms of diffuse peritonitis and no vomiting, the local infectious conditions and the toxæmic state caused grave anxiety for three days, during which time repeated and abundant subcutaneous injections of saline solution were very useful. From the fourth day, however, all the symptoms disappeared, and recovery occurred without any complication.

There are few cases in which surgical initiative is more essential than in these *septic forms* of appendicitis; practically our attitude towards them must be the same as towards a case of peritonitis due to perforation.

The pulse in these cases furnishes the most important indications and gives the danger signal; if it is small, bad, above 115 in the adult, or 125 to 130 in the child, with a temperature of 100° or even 99°, if **the disagreement**[1] increases, the pulse increasing in frequency as the temperature falls, no matter what the apparent benignity of the other symptoms may be, all hesitation must be laid aside, any delay may be fatal; operate at once.

(*B*). The disease appears to be running a satisfactory course, when on the third, fourth, or fifth day the symptoms become aggravated: vomiting reappears, the temperature rises, and, most important of all, the pulse becomes fast and feeble, out of proportion to the other signs. These sudden exacerbations at a time when a favourable course seemed duly established also demand immediate operation.

Case 34.—A dentist, 25 years of age, suffering from an apparently very mild attack of appendicitis, was seen by us. The affection had begun some days before with acute pain, but since then, apart from the pain and some vomiting, there had been absolutely no serious symptoms. In the iliac fossa an elongated swelling, compact, almost hard, about the thickness of the thumb, and apparently adherent to the outer part of the region, could be felt. The

[1] As Jalaguier has pointed out, the disagreement may render itself evident in the inverse ratio: the temperature remains high, while the pulse falls to 60 or even 50; the signification is the same. These indications depending on the pulse are not absolutely constant, it is true; but in the great majority of cases, when carefully studied, their value is undeniable.

temperature was 100·8°, the pulse 100, and strong. There appeared to be no urgency about the case.

Two days later, however, the abdomen began to distend, and became generally tender; the face was pinched, the pulse not so good; "there was a change for the worse," the favourable characters of the case were no longer evident; I hastened to operate, and it was quite well that I did so. On the outer side of the cæcum I found a small quantity of purulent fluid, and in the centre of the cavity, surrounded by a few loose adhesions, was the appendix, gangrenous, flaccid, and greenish in its lower two-thirds. To the inner side, the general peritoneal cavity was perfectly open, and there could be no doubt that the infection was rapidly extending in that direction. The patient remained for some days in a rather alarming condition, vomiting a little; then improvement set in, and in three weeks he had quite recovered.

(*C*). Towards the sixth day, *when defervescence ought to be expected*, the temperature remains high or even rises; it oscillates widely, the pain becomes more acute, and the swelling increases; often it softens; it no longer forms a diffuse infiltration, but takes the shape of a rounded elevation, very painful at its centre and in the vicinity of the iliac spine; here again the indications are clear; to wait longer is simply to court danger; **operation is necessary.**

Such a recrudescence of symptoms may occur after complete defervescence extending over several days, and may present itself with all the characters of a fresh attack. As we have already said, the explanation is often to be found in some error of treatment; but even in cases where care has been in no way relaxed, there may be foci in which the inflammation has not completely subsided, and which become active again as soon as the immobilization ceases to be absolute. These cases are unsuitable for further temporizing measures; *a relapse should therefore be considered as an indication for immediate operation.*

Case 35.—A lad, 16 years of age, who had suffered from constipation and indefinite abdominal symptoms for some months, was suddenly attacked with acute pain in the right iliac fossa. He was put to bed forthwith, and treatment by immobilization begun. On the third day a thick, indurated, elongated swelling, tender to pressure, was detected lying obliquely in the appendix region. There had been a little vomiting at the beginning of the illness, but it had quite ceased. The general condition was excellent, the pulse was 90 per minute, and the temperature had not reached higher than 100·4°. It was apparently a mild attack of appendicitis running a favourable course.

A week later, when the temperature had been normal for four days, and when the attack seemed to have quite passed—the patient having all the time been kept in bed and care in no way relaxed—the temperature suddenly ran up to 101°, the pain returned, and in two days the small iliac mass had enlarged to three times its former size, causing a marked prominence of the abdominal wall, and was manifestly fluctuating. Operation was performed: I made the usual iliac incision and opened into a *large abscess cavity* lying behind and to the outer side of the cæcum, in which I failed to find the appendix; some reddish fragments of tissue attached to the extremity of the cæcum seemed to be the sole remains of the organ; the cæcal wall was bleeding and very friable, and I was afraid that a fæcal fistula would probably develop. Fortunately no such complication occurred, and the cavity closed without undue delay.

There is, therefore, a whole series of possibilities in which immediate

operation is necessary, in which delay is unjustifiable, and to which the method of treatment by immobilization is inapplicable.

The need for immediate operative measures arises still more frequently and more urgently in the second group of cases which we are now about to consider.

II. **The Patient is not seen until some Days after the beginning of the attack, and during that time the Appendicitis has been untreated or badly treated.** The data of the problem are now quite different; the situation is no longer a definite one, and infection has got the start. We are no longer dealing with a commencing disease, but with one in a more or less advanced stage and often beyond the influence of any treatment.

Careful note should always be taken of the date of onset and the duration of the symptoms, and their nature and intensity compared with those which are to be expected in an ordinary case pursuing a favourable course, and which we have already studied.

Is there still time to have recourse to the treatment by immobilization? Can it be adopted without danger and with any prospect of real benefit? That is the first question. An affirmative answer involves heavy responsibility, and must therefore only be given after serious consideration, and be based on undoubtedly favourable elements in the case.

(*A*). All the signs of commencing "resolution" are present: a falling temperature, and a pulse in keeping with the temperature; the abdominal pains are moderate, and there is a hard swelling in the iliac region. The attack has evidently been benign, and spontaneous resolution seems likely to ensue; naturally there is nothing to do but to follow and assist the process.

Be cautious, however, and make sure, by careful examination and a minute analysis of the facts of the case, that the condition is actually improving. Do not forget those deceitful lulls which are only too common in some toxic forms of appendicitis. There is no lack of examples.

Case 36.—A man, about 30 years of age, was taken ill on Monday with symptoms of appendicitis. He was put to bed, purged, and ice applied to the abdomen.[1] The pain abated, and on Thursday the patient got up to breakfast. This freak was followed by a recrudescence, apparently of moderate severity. I did not see him until the Saturday evening: the face was then somewhat drawn, but not markedly so; the temperature was 100·4°, and the abdomen only slightly tender in the right flank (the patient was, however, very stout and palpation was difficult), but the rapid, feeble, intermittent pulse (115 per minute), and the quick laboured respiration indicated the real gravity of the situation. I declared that operation was urgently necessary, but at the same time gave a very grave prognosis, which caused a good deal of surprise.

[1] This strange combination of purgative and ice is by no means uncommon. It indicates an absolute lack of appreciation of the principles of treatment by immobilization. It is impossible to insist too strongly on the harm that is caused by purgatives; it is impossible to say how many times cases of appendicitis, primarily benign, have been suddenly aggravated by this dangerous and irrational medication.

I have seldom seen such extensive appendicular suppuration. The iliac fossa was full of pus, which extended downwards into the pelvis, upwards behind the colon to a subdiaphragmatic pocket, and in an inward direction was diffused amongst the coils of intestine; the appendix was of enormous size, was perforated in several places, and was resected without difficulty; the peritoneal cavity was washed out with boiled water, free drainage provided, and the operation terminated as speedily as possible. Large injections of saline solution were administered. Nothing was of any avail: the patient died on the Sunday.

Case 37.—A young woman, 22 years of age, was brought to us suffering with pain in the right iliac region; it had begun suddenly some days before, but had lessened very considerably, and although still quite definite at McBurney's point, it had much less than the usual degree of severity. There had been some bilious vomiting, the abdomen was rather full, but soft and yielding, and tenderness was found only in the right iliac region. There the abdominal wall became rigid when touched, but still permitted deep palpation, which detected no appreciable swelling. The pulse was 110 and of good quality, the temperature 100·4°, the face was well coloured, and speech quite easy and perfectly normal, and the patient recounted without any fatigue all that had happened during the past two days. We remained with her for some time, and our impression continued satisfactory. It was then 10 o'clock at night. We ordered a little opium to be given, ice to be applied to the abdomen, and prohibited the administration of anything by the mouth.

Next morning at 8.30, the situation had altered very seriously, the abdomen was more distended and more tender, the pulse was rapid, and the features pinched. We operated forthwith. We found a perforated appendix and diffuse peritonitis, purulent lymph on the coils of small intestine, and turbid fluid in the abdomen. In spite of all our efforts the patient died during the night.

(*B*). The patient may present a *typical acute appendicitis, running an evidently favourable course*: the temperature is not excessive, there is no vomiting, no distention.

If the symptoms are of short duration, the case being in its third, fourth, or fifth day, and particularly if a definite, firm, indurated swelling is found, the treatment by immobilization may be adopted; but it must be applied immediately and thoroughly, not in an indefinite or half-hearted way.

Accordingly as the interval from the day of onset lengthens, the persistence of fever, even in the absence of any serious signs of infection, indicates suppuration and the existence of conditions which can only be influenced by surgical measures.

If after from the eighth to the tenth day the temperature continues high, say at 101° to 102°, even though the pulse may be good and of average frequency, or even if a well-defined swelling is found and the appendicular focus appears to be strictly localized, nothing is to be gained by waiting, while delay may be associated with serious danger to the patient. Remember those enormous foci of suppuration, retrocæcal and retrocolic, intracæcal or pelvic, which always cause so much astonishment when they are opened, and which increase and progress in the depths of the abdominal cavity without any special reaction, and the real extent of which may not even be suspected after the most minute external examination.

Lastly, when dealing with an unknown case of appendicitis which one has not had the opportunity of following day by day from the onset, supervision must be even more rigorous, if that is possible: on the least bad symptom or the slightest arrest in an established improvement, if the pulse becomes more frequent, or the temperature rises again, if the swelling increases: do not wait for further information, but **operate.**

(*C*). All hesitation vanishes and **immediate operation is demanded** in the following conditions, which are quite common in everyday practice:—

1. **You find an Iliac Abscess.**—The following is an example amongst many of similar characters:—

Case 38.—The patient was a strong robust-looking girl, 19 years of age. The onset of the attack had occurred ten days previously with acute pain in the right iliac fossa; for two days there had been vomiting, which had become definitely fæculent. The temperature was 104·8° in the vagina, the pulse 130 but fairly strong; the face was pale and expressive of suffering, without being pinched. The abdomen was universally tender; it was particularly painful in the right iliac fossa, where, notwithstanding the resistance of the wall, *a very large tense mass, dull and fluctuating*, was detected without difficulty. The mass filled the whole of the iliac region and extended upwards to about three inches above the iliac spine and inwards to the outer border of the rectus muscle. It was manifest that the iliac fossa was the seat of a huge abscess. On rectal examination there was found a tender swelling high up and to the right; fluctuation was doubtful, as the examination was very painful and was consequently short and incomplete. On vaginal examination, although the uterus was not fixed (there was, by the way, no history of any previous pelvic trouble), the same tender swelling was felt at the right side of the pouch of Douglas.

Here, then, was a situation as definite as it could well be and with urgent indications. The presence of a *fluid accumulation in the iliac fossa, the high fever, the signs of peritoneal reaction*—nothing was wanting, and all pointed to the urgent necessity for immediate operation, which had indeed been too long delayed already, considering the date of onset of the symptoms and the size of the abscess. The iliac incision was made forthwith under ether anæsthesia. After the abdominal wall was sectioned we encountered, first of all, a mass of thickened and adherent omentum; on raising it a stream of fœtid pus escaped, and the finger penetrated into a large cavity which extended behind the uterus to the bottom of Douglas' pouch; the quantity of pus which escaped was without exaggeration at least two pints. After the cavity had been evacuated and cleansed with gauze swabs, we discovered *the appendix, large, blackish, and perforated at its extremity*, lying behind and to the outer side of the cæcum. It was gently enucleated, freed from below upwards, and, after ligation of the base, divided with the thermocautery. The operation was completed by placing a large drainage tube surrounded with gauze in the cavity, and suturing the extremities of the wound. Convalescence was protracted, as was to be expected, considering the enormous size of the abscess and the delay in operating.

In cases of this type, all the indications are perfectly clear: **the abscess must be opened, not on the morrow, but at once, just as soon as the necessary preparations can be made.**

At other times the general symptoms are less urgent, but the existence

of a fluctuating swelling is recognized quite definitely; in the face of this single indication, action must be the same as before.

Case 39.—A young woman, 21 years of age: sudden onset with *acute pain* in the right iliac fossa; there was a moderate degree of fever in the early days, some vomiting, and obstinate constipation. However, the attack had not been severe, and when I saw the patient on the sixth day the general condition was satisfactory. The temperature did not go beyond 100·2°, the pulse was 110; there was no vomiting; the abdomen was not distended, but was still very painful in the right iliac fossa, and in that position *a rounded mass, the size of a tangerine orange, definitely fluctuating*, was quite distinctly felt. There could be no doubt of the existence of an abscess. Operation was performed forthwith: a large foul-smelling abscess was opened which extended in a downward direction as far as the horizontal ramus of the pubis, and in the pus a fæcal concretion was found. No trace of the appendix was seen; all surgical investigations were very carefully executed to avoid risk of breaking down the protecting adhesions and opening into the general peritoneal cavity. The wound was drained and partially sutured. In a month recovery was complete.

Undoubtedly the danger is much less in these well localized forms of suppuration which provoke but very mild reactions in the surrounding tissues. Still, the future is none the less uncertain, and opening these abscesses at once is simply obeying the ordinary wise rule of general surgery. Further, never be deceived by the lull, or by the mild evolution of the symptoms; the infected focus spreads insidiously, and *it will always be found that the lesions are much more serious than had been suspected.*

Therefore it is a well established rule—and illustrations could be multiplied indefinitely—that **as soon as a fluctuating swelling has been detected in the iliac fossa,** after the sudden onset and with the well localized pain which indicates appendicitis, *then operate at once.*

2. But fluctuation is by no means always definite, and often it will not be a fluctuating swelling which is felt in the iliac fossa, but **a large thickened and painful mass.**

Case 40.—A man, 28 years of age, while mounting on horseback, felt an acute pain in the right side of the abdomen. The pain persisted and increased, vomiting supervened, and three days later when we saw him his face was pale and pinched, the pulse small; the temperature was 100·2°, and the abdomen was flat. On palpation, severe pain was felt in the right iliac fossa, particularly acute at the mid-point of the line between the iliac spine and the umbilicus—McBurney's point. The iliac fossa was occupied by *a doughy, almost hard mass, which formed a prominent swelling.* We operated forthwith. The cæcum first appeared in the wound; by separating it from before backwards, we opened into *a large retrocæcal abscess*, in the midst of which the appendix, gangrenous and perforated at several points, was found. The organ was liberated and resected. Drainage was provided. The patient recovered.

Another case follows in which the general characters were more benign, but in which the existence of an abscess and the urgent need for operation were clearly indicated by the volume of the pericæcal mass.

Case 41.—A young man, 25 years of age, onset with a shiver, and moderate but sudden pain in the right iliac fossa. He vomited on the day of onset; after that there was no more vomiting, but the pain persisted, though the temperature never exceeded 100·4°. We saw him on the tenth day; the abdomen was not distended; there was very acute pain at McBurney's point, and palpation detected *a thick mass* in the iliac fossa, forming an obliquely lying swelling about 2 ins. broad; *this swelling was doughy, of unequal consistency, but nowhere fluctuating.* Iliac incision: under a thick layer of omentum, and surrounded by purulent lymph, we opened an abscess, at the bottom of which the large, thickened appendix, ulcerated at its apex, was found, isolated, and excised. Drainage. Recovery.

Notice that the volume of the perceptible mass—and I am speaking of cases in which the parietal resistance does not seriously interfere with palpation—does not indicate in any certain manner the volume of the deep-seated accumulation; in other words, **even when only a comparatively small swelling is discovered in the iliac fossa, it is impossible to say that pus, perhaps a great deal of pus, is not present.**

In support of this statement we need merely mention the retrocæcal, subcæcal, and intracæcal abscesses, of which we shall again have cause to speak, and above all, **pelvic appendicitis.**

Case 42.—A strong, healthy man, 52 years of age, fell ill in the first fortnight of October with pains in both iliac fossæ, but without any definite localization, fever (temperature 102°–103°), but no vomiting; under the influence of treatment the symptoms subsided, and in about a week he seemed so much better that he was able to get up and in part to resume his occupation. Three days later, however, he was compelled to return to bed. I saw him twelve days after the first onset of symptoms; the temperature was ranging between 101° and 103°; the pulse was 105 and of good quality; the general aspect was good and the tongue moist; there was no vomiting; the pain was continuous and very acute, and was situated in the right iliac fossa. In that region, and more markedly behind the pubes, palpation elicited acute tenderness; there was frequent but not painful desire to micturate. The external examination revealed nothing but a very limited thickening, a mere narrow band, along the outer border of the right iliac fossa. In view of this *relapse*, the fever and the pain, I insisted on the need for immediate operation. The iliac incision conducted me to the cæcum, which was adherent. While carefully separating its outer border I opened into the abscess, and a stream of extremely fœtid pus escaped. I then penetrated into *an intrapelvic pocket which occupied the whole of the right half of the pelvis*, and which descended so low that it was with difficulty my finger reached the bottom. The abscess cavity was cleansed with gauze swabs, and after excision of a blackish necrotic strip of tissue which appeared to be a fragment of the appendix, and without any prolonged search, drainage was provided and the operation terminated. During the first ten days, the discharge from the drainage tubes remained very bad smelling; under the influence of irrigation with hydrogen peroxide this finally ceased, and the cavity then filled up rapidly.

In these cases of pelvic appendicitis, *rectal* and *vaginal examinations* are extremely useful, and serve to disclose the appendicular focus or a deep-seated abscess; when combined with iliac palpation (*Fig.* 408), they allow a painful area, an infiltrated zone, or a fluctuating mass to be detected, usually high up at the right side, and so confirm the diagnosis. This

exploration by the pelvic route is of special importance in the doubtful cases, because in them the pain at McBurney's point is often wanting, or is transferred low down close to Poupart's ligament, and the iliac fossa remains in great part free. Rectovesical symptoms, rectal tenesmus, vesical tenesmus, frequency of micturition, are also symptoms of value, but are not constantly present.

The conclusion is this: **when a thick, doughy, tender mass is felt in the iliac fossa and the fever persists, even though the general symptoms are not urgent, operate immediately.** Here again, almost invariably, one is astonished and alarmed by the extent of the lesions which are discovered and by their contrast with the results of the external examination.

Fig. 408.—Rectal examination in appendicitis.

3. At other times, and still too commonly in the delayed operations, is found **Generalized Peritonitis** which has developed more or less insidiously.

How often has it happened to me in urgent hospital surgery, on making the iliac incision, to meet with that brownish, turbid, dirty fluid bathing the intestinal coils, with scarcely a trace of adhesions, which indicates the most malignant form of peritoneal infection, or again, on opening the abdomen, to see the intestines covered with purulent lymph, and after the separation of some adhesions, streams of pus flow from all parts of the peritoneal cavity, indicating another variety, namely diffuse purulent peritonitis, a variety which is, however, as we shall see, not so absolutely hopeless. Cases of appendicitis on the fifth or sixth day, sometimes as late as the eleventh day; cases of appendicitis with sudden onset but deceptive course, without striking reactions, without high fever, without vomiting—at least in the early days—the insidious evolution of which,

simulating a benign course or even actual improvement, has thrown the observer on the wrong scent. In these cases of peritonitis of appendicular origin, the question of the **limitations of operation** sometimes arises.

In our opinion, the only contraindications to operation are the certain signs of approaching death: the coldness of the extremities and the disappearance of the pulse. That recovery is quite exceptional is indisputable; that death may be inevitable, in that variety of hyperacute peritoneal infection in which turbid, brownish fœtid fluid, which has been compared to dirty beef-tea, is found in the peritoneal cavity, we have no means of contesting; but we can never know in advance what we shall find in the peritoneal cavity, and often the patients are young and possess quite unexpected vital resistance; if they can bear the incision of the abdominal wall and the peritoneal lavage (and saline solution given subcutaneously or intravenously is a great help),[1] it is our duty to give them that last chance.

Such are the principal indications for the emergency operation during the course of appendicitis, and I add again, **when in doubt, operate.**

This last formula, extreme though it may appear, nevertheless expresses the most prudent and wisest course, and I may add that *it is applicable even to the cases in which the diagnosis of appendicitis is not definitely established*—with the simple reservation that the symptoms are urgent.

The diagnosis of appendicitis has often been wrongly made. We shall not speak of those diagnostic errors due to superficial examination and hasty deduction which may lead, and indeed have sometimes led, to operations which, to say the least of them, are useless.[2] But apart from these cases, there are others in which, though a mistake may be made as to the point of departure of the pathological conditions, operation is undoubtedly necessary and beneficial.

I need only refer to some **intestinal obstructions**, to some cases of **perforative peritonitis**, and to certain forms of **acute tuberculous peritonitis** which simulate appendicitis perfectly: in the following pages I shall cite some illustrative cases.

[1] If the renal function is adequate, and the organs have not been too seriously affected by the septic absorption. When the injection of fairly large quantities of saline solution is not followed by comparatively rapid diuresis, the prognosis must always be considered as practically hopeless; this holds good in all infective conditions, as we have repeatedly had occasion to observe.

[2] Confusion is possible with renal colic, enterocolitis, constipation, simple indigestion, commencing typhoid fever. It is advisable to emphasize the last possibility: (*a*) At the commencement of an attack of enteric fever, the iliac pain may be attributed to appendicitis: that is an error of diagnosis pure and simple, which may lead to a useless and—under the circumstances—even a dangerous operation: (*b*) The typhoid inflammation may primarily affect the appendix and the end of the cæcum, and a doughy pericæcal swelling may be discovered and constitute a quite legitimate indication for operation: (*c*) A diagnosis of typhoid fever may be made because of the slow onset of the symptoms, the character of the temperature, the diarrhœa, and the mental apathy, while the condition is in reality due to appendicitis. One should always think of appendicitis in these indefinite cases and look for it, taking note of the localization of pain, the tension in the iliac region and, if possible, by means of a blood-count; leucocytosis (above 15,000) is a valuable sign in favour of appendicitis.

Brun, while thinking that he had to do with a case of appendicitis, found an ovarian cyst with a twisted pedicle.[1] Such cases are not uncommon. I performed an emergency operation for appendicitis some years ago on a girl of eighteen, and found a dermoid cyst of the right ovary, also with a twisted pedicle.[2] Rupture of an extra-uterine pregnancy may cause a similar mistake. Legueu has insisted on this point, and in one case where I myself had made a diagnosis of grave appendicitis, when I made the usual iliac incision I found extensive intraperitoneal hæmorrhage; however, the necessary operation was successfully carried out by the lateral route, and the patient recovered.

Of course, the characteristic pallor in cases of internal hæmorrhage, the presence of a large tumour with definite outlines, in the case of a cyst with twisted pedicle, the previous history, and the account of the first symptoms, will often solve the problem; but still, if any doubt remains, one must not wait till the facts become patent; in the face of urgent symptoms immediate action is imperative, and one may say, in a certain sense, that the exact diagnosis is a matter of secondary importance, since in any case the same procedure is indicated.

Inflammatory conditions of the right uterine appendages require special mention; they may in certain cases simulate all the appearances of acute suppurative appendicitis; while, in other patients, tubal disease and appendicitis may occur together, and give rise to a very interesting combination of symptoms.

I cannot here enter into a discussion of these mixed forms, still less of the causation of the morbid association. From the standpoint of urgent surgery we can only insist on the two following possibilities: (1) **A diagnosis of acute salpingitis,** or pelvic peritonitis of tubal origin, is made, whereas in reality **the condition is one of appendicitis**; (2) **Acute salpingitis is taken for appendicitis** and operated on as such by the iliac incision. Lastly, the co-existence or the **combination of tubal disease and appendicitis** is by no means uncommon, but occurs particularly in the subacute and chronic forms which do not demand immediate decision. *To ascribe the acute peritoneal symptoms really caused by a perforative appendicitis to pelvic peritonitis of tubal origin*, is a mistake which it is sometimes very difficult to avoid, but one the consequences of which may be disastrous.

Bouilly[3] has published and discussed several very striking examples: in cases of this kind the appendicitic symptoms are not well defined; the pain is from the first widely diffused over the abdomen, or at least over the hypogastric region; the pain is no more, or scarcely more, localized to the

[1] Brun, "Kyste de l'ovaire à pédicule tordu pris pour une appendicite," *Société de chirurgie*, 31 mars, 1897.

[2] G. Niot, *De la torsion du pédicule des kystes dermoïdes de l'ovaire droit.* Thèse de Paris, 1901.

[3] Bouilly, "Appendicite ou annexite," *Congrès franç. de chir.*, 29 oct., 1898. See also the theses of E. Leroy, *Diagnostic différentiel de l'appendicite et des affections péri-utérines*, 1897, No. 79, and of A. Barnsby, *Appendicite et annexite, co-existence des deux affections, pathogénie, symptômes, traitement*, 1898, No. 317.

right iliac fossa than to any other region of the abdomen ; it may have originated in a position distant from the cæcum, particularly in the left iliac fossa ; palpation is misleading because of the peritoneal sensibility and the tension of the abdominal walls.

In short, it is easy to recognize the existence of an acute peritoneal reaction ; it is almost impossible to determine the causal and initial lesion. The results of the local examination may contribute to a mistake ; the tenderness and thickening which are detected in the posterior or right lateral vaginal fornix are sometimes only an indication of the pelvic seat of the appendicitis ; large peri-appendicular abscesses may extend into Douglas' pouch and become accessible to vaginal and rectal examination. The diagnosis can therefore only be established " by shades of differences," to use Bouilly's expression ; in appendicitis the symptoms are from the first of a graver character, the indications of septic absorption are more marked, the temperature is higher, and the evolution is, as a rule, progressive ; while in pelvic peritonitis of tubal origin the severe onset is usually followed by a comparatively rapid subsidence. There is in fact no pathognomonic feature, and the only conclusion to be drawn is that operation must be undertaken without delay as soon as the first serious peritonitic symptoms appear, without waiting for a useless demonstration of the exact nature of the condition, which too often has been given by unexpected death.[1]

In another group of cases, on a **diagnosis of acute appendicitis, the ordinary iliac incision is made, but instead of an inflamed appendix, it is a high situated pyosalpinx which is found.** The mistake is, however, of minor importance, and though the lateral incision does not give very convenient access, still the necessary measures can be successfully executed.

Case 43.—A woman, some 20 years of age, was brought to hospital with alarming peritoneal symptoms. They had begun suddenly the evening before in the right iliac fossa with an acute pain, which had rapidly extended over the whole abdomen. It still remained severe, particularly in the appendicular region. The abdominal distention was very considerable, and there was frequent greenish vomiting ; the temperature was 102°. In spite of the pain

[1] For instance, a woman 35 years of age was admitted to the Beaujon Hospital on February 11th, 1896 ; in January she had had a miscarriage, followed by a profuse hæmorrhage which had persisted for three weeks : a fortnight before admission some pain began to be felt in the right iliac fossa, and the uterine bleeding recurred. There was obstinate constipation, but no vomiting. On vaginal examination, a mass the size of an orange was felt in the posterior fornix ; this mass had fairly definite borders ; it could also be felt by abdominal palpation, and appeared to be fluctuating. A diagnosis of right pyosalpinx was made, and operation deferred for a few days. On February 13th the condition became suddenly worse, in consequence of an acute attack of pain followed by syncope, which raised temporary suspicion of the rupture of the tube ; however, the exacerbation subsided, the pain diminished, and an examination showed no change in the local conditions. Median laparotomy was performed on February 15th ; a yellowish mass covered with adherent omentum and filling up the entrance of the pelvis was first encountered ; on the first attempt at separating the omentum, the swelling burst and a great quantity of pus escaped ; it was then discovered that the cavity extended right to the bottom of Douglas' pouch ; in its walls both sets of uterine appendages were recognized ; they were covered with false membrane, but were healthy ; on the right side a pus track led to the iliac fossa, where the appendix was found enormously thickened, gangrenous, and perforated. The organ was resected, the huge cavity was cleansed as carefully as possible, and drained. The patient died during the day.

and distention a fluctuating mass was quite definitely recognized occupying the right iliac fossa. A vaginal examination gave no information of importance ; there was a little thickening and tenderness in the right fornix.

We made a diagnosis of suppurative appendicitis, and operation was performed forthwith. The abdomen being opened by the iliac incision, we at once discovered *a tense, oval, reddish mass* which extended into the pelvis and was retained in the iliac fossa by widespread adhesions, for the most part soft and of recent formation. By following the mass downwards it was easy to determine that it was in reality *a large pyosalpinx.*

After having carefully isolated it with gauze compresses, we punctured it and evacuated a large quantity of pus ; then the puncture opening was closed with forceps, and the sac, which was easily enucleated, was brought out through the lateral incision, and drew after it the right uterine cornu, which appeared at the bottom of the wound. The pedicle was ligated close to the uterus, divided with the thermo-cautery, and the septic focus drained.

If it appears too difficult to perform the salpingectomy by the lateral route, more room can be obtained by prolonging the incision above Poupart's ligament, or perhaps it may be better to close the lateral wound and have recourse at once to median laparotomy.[1]

Finally, the distinction between *abscesses of tubal origin* and *those of appendicular origin* becomes quite impossible in those abnormal but now well recognized cases of appendicitis **with left-sided abscess.** The predominence of the symptoms on the left side in certain forms of appendicitis has been carefully studied by Termet and Vanverts.[2]

In one of our patients this localization was so definite as to induce us in the first instance to think of suppuration originating in the uterine appendages.

Case 44.—The patient was a young woman, 21 years of age and very stout, who had been in excellent health until November 4th, 1895, when her illness began. The onset did not appear to have been very severe ; the pain was situated in both iliac regions, it soon radiated over the abdomen, and was accompanied by obstinate constipation and vomiting. She was admitted on November 4th into M. Fernet's service, and we saw her on the 12th. The condition had then become much worse : there was complete constipation, the vomiting had become greenish, and notwithstanding the considerable distention, we had no difficulty in feeling *a large mass which filled the whole of the left iliac fossa,* and in which deep-seated fluctuation could be made out. On the right side palpation revealed no special tenderness ; there was a certain degree of sensibility in that position, but no more than in the rest of the abdomen. The patient was a virgin : menstruation had been rather irregular, and a period had been suddenly interrupted by the onset of the symptoms.

There could be no doubt that we had to deal with a large iliac or ilio-pelvic abscess, with signs of serious peritoneal reaction, but the pathogeny of the condition was doubtful. During the day I opened the abdomen by a left iliac incision, and found first of all a mass of thickened and adherent omentum, below which a tense swelling could be felt. While the omentum was being

[1] On one occasion I succeeded in removing both pus-tubes, which were not adherent, by the right iliac route.

[2] Termet and Vanverts, " De la prédominance des symptomes à gauche dans l'appendicite." *Gaz. des hôp.*, 1897. See also P. Barbet, *De quelques formes anormales d'appendicite avec abcès iliaque gauche.* Thèse de doct., 1898.

gently raised the abscess burst, and a stream of very fœtid pus of fæcal odour escaped. After the evacuation was complete I penetrated into a huge cavity which extended *from left to right, and appeared to go towards the iliac fossa of the opposite side*. The cavity was irrigated and drained. The alarming symptoms disappeared and the patient recovered, but for several months a fistulous track remained. It extended towards the right side, probably to some unabsorbed residue of the appendix, and had to be repeatedly curetted before it finally closed.

While in dealing with urgent surgical conditions it is well to be aware of these abnormal cases, one must never expect too much from the external examination, which is often misleading: frequently a complete diagnosis is impossible; but symptoms definitely indicating the exact nature of the causative lesion must not be awaited, and in the presence of positive signs of peritoneal infection **immediate action is imperative.**

THE OPERATION IN APPENDICITIS.

I. Let us take first the simplest case, that of a purulent collection filling the right iliac fossa. What we are about to say with regard to the preparation and the preliminary steps applies equally to the other forms. The patient is placed flat on his back, with the limbs well wrapped up; anæsthesia is carefully induced with ether or chloroform. The pubes are shaved, and the whole surface of the abdomen, or at least the whole of the subumbilical zone, is soaped, brushed, and disinfected in the usual manner.

If there is a large, tense, and prominent swelling, it will be well to avoid any too energetic brushing and rubbing, which might easily rupture the abscess. I have seen a prominent abscess suddenly subside under the hand of an assistant, as vigorous as he was zealous; it had burst; but happily the pus had not time to spread in the peritoneal cavity, and no bad results ensued.

Once the patient is well under the influence of the anæsthetic and in a condition of complete muscular relaxation, **never omit to make a final examination before beginning the operation** (Fig. 409).

Often the relaxation of the abdominal wall, which no longer "*defends itself*," will allow a swelling, with more or less definite outlines, to be felt in the right iliac fossa, or again, enable the surgeon to recognize by *oblique inspection* a notable degree of asymmetry between the two sides of the abdomen.

Palpation will furnish the more definite information, and usually one or other of the following conditions will be found: **a definitely fluctuating, tense, circumscribed swelling,** clearly limited on the inner side; **a thick dense mass,** with doubtful fluctuation or with an irregular surface and ill-defined borders below and towards the middle line, or **a small indurated mass,** rounded or nodular, which might readily be taken for the appendix itself.

Sometimes the tumour observed prior to the induction of anæsthesia seems to have almost disappeared; do not hesitate, however; the performance of the operation will speedily furnish an explanation of the occurrence. Let us add also that any fears of the existence of diffuse peritonitis will be in large measure confirmed if, after the patient is anæsthetized, the sensation of a diffuse thickening persists, and if the abdomen does not become flatter but remains tense and full.

Such a pre-operative examination will not occupy much time, and may provide very useful information.

Fig. 409.—Palpation of the right iliac fossa. The flexed fingers of the two hands gently depress the abdominal wall in the iliac region from within outwards.

Make an incision about 4 inches in length, with its central point an inch internal to the antero-superior iliac spine (*Fig.* 410). If there is a large fluctuating swelling the incision will be made over its most prominent part; in all other cases it is well to keep *as close as possible to the outer border of the iliac fossa*. We shall see why immediately.

Under the skin, two or three small arteries require to be secured, and then the *aponeurosis of the external oblique* is divided freely for the entire length of the cutaneous incision; a forceps secures each lip of the aponeurosis. The operator is now on the muscular plane (the internal oblique and the transversalis).

It happens sometimes that the abscess has already made its way into the tissues of the abdominal wall, and that the pus begins to escape as soon as the external aponeurosis is divided; the cavity thus opened is usually an offshoot of the main one, and the channel of communication can readily be enlarged with the finger.

Incise the muscular layer in the direction of the superficial wound

(*Fig.* 411) without delaying to look for the interval between the two muscular planes ; in the male this layer is often thick ; cut through it steadily until the whitish sheet is seen which underlies it. This is the *fascia transversalis*, and under it is the *peritoneum* ; now proceed cautiously while the bottom of the wound is exposed by means of two retractors.

Quite often this deep layer is œdematous, yellowish, and bulging, and through it fluctuation can be quite plainly felt ; in that case the infiltrated fascia may be incised without fear, and on making a small opening in the peritoneum (*Fig.* 412) a jet of pus will escape ; two pairs of forceps are at once applied to the edges of the incision, which is then extended with the scissors upwards and downwards.

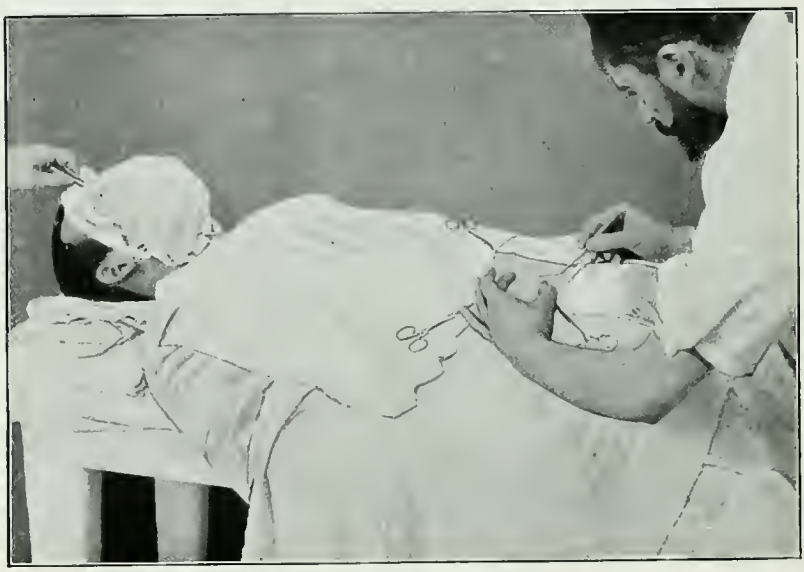


Fig. 410.—Operation for appendicitis. The operation area ; the incision.

The abscess is opened : the pus, which is often extremely fœtid, is allowed to run away ; the cavity is then cleansed with gauze swabs, care being taken to avoid any rough manipulations, which might cause considerable bleeding from the wall ; and the surgeon will proceed to inform himself by sight and touch of the presence of any diverticula of the main cavity.

It is most frequently in *an upward direction under the cæcum* that any such prolongation will be found ; a thread of pus will be seen coming from that position, and a touch with a swab will expose the orifice, which will then be cautiously enlarged with the finger. Follow the cavity also in a *downward direction*, without tearing anything or rupturing the adhesions ; the finger will often go to a variable depth, towards the sacral promontory, or the pelvic cavity, sometimes right to the bottom of the pouch of Douglas ;

not uncommonly, in the large abscesses we are at present considering, the cavity is divided into two pockets: an upper pocket, lying to the outer side of the cæcum, and a lower pelvic one, the two being partially separated by a feeble barrier of false membrane which gives way at the first touch of the finger.

This exploration will have made it clear that the cavity, however large it may sometimes be, is completely shut off from the general peritoneum in all directions, and under the anterior lip of the parietal wound the cæcum or the omentum will be seen, adherent to the anterior layer of the peritoneum, and forming a barrier in that direction.

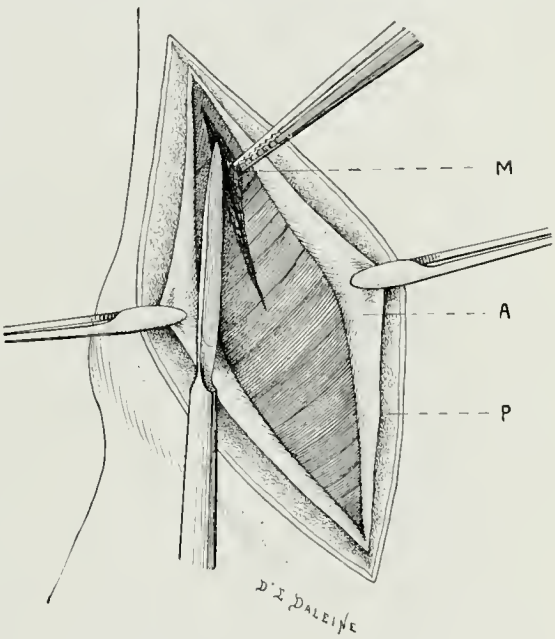


Fig. 411.— Operation for appendicitis. The aponeurosis of the external oblique is incised and its edges secured with forceps; dividing the muscular layer. (M) Muscular layer (internal oblique and transversalis). (A) Aponeurosis of the external oblique. (P) Skin.

Be careful not to destroy the protective adhesions; carefully cleanse all the recesses of the cavity with gauze swabs in holders. Remember — I shall have occasion to mention it again in relation to other operative conditions — that the yellowish coating of purulent false membrane which covers the cæcum is often very adherent, and that *the intestinal wall underneath is often friable* and may very easily be seriously damaged by too energetic cleansing. Special attention should be directed to the region below the cæcum and around its blind end, where, as we have already mentioned, the orifice of a secondary cavity is commonly situated.

During this cleansing, the appendix, or some thickened cord or nodular mass which seems to resemble it, may have been seen or felt.[1] Practically there is no invariable condition, and consequently there can be no absolute rule for dealing with the appendix in these cases. Therefore we do not say *the appendix ought not to be looked for*. If it

[1] Be cautious, however, unless the opinion is confirmed by ocular inspection, and do not blindly commence a separation which may quite well affect an adherent, thickened, unrecognizable loop of small intestine, and may be associated with very serious danger.

presents itself quickly, or if it is easily found and isolated without extensive separation of protecting adhesions, why should the opportunity thus presented of completing the operation be renounced. To leave behind a sloughing perforated appendix can never be a matter only of indifference; we have repeatedly seen obstinate fistulæ succeed an operation which had been limited to the simple opening of an abscess. But there is another reason: the search (of course a very cautious search) for the appendix will often lead *to the finding and opening of various secondary foci*, lying below or to the inner side of the cæcum, which might otherwise have passed undetected. To our mind, the wise practice is this: *always carefully examine the walls of the cavity just opened*; if the appendix shows itself quickly—below and behind the cæcum usually—do not fail to remove it; if it does not appear, then search for it carefully at the position where it is most commonly met with, **behind or below the cæcum.** In carrying out this search, do not leave the iliac fossa; do not venture inwards, breaking down blindly and by chance anything that comes in the way, but gradually raise the outer border and lower end of the cæcum, separating the adhesions very gently. By working in this manner the muscular wall of the cæcum will not be lacerated, nor will the advantage of a localized abscess be lost by breaking down the protecting adhesions. Stop in good time if nothing is found; the object of the operation is not to resect the appendix, but to open freely and drain the abscess cavity; and the quite simple and harmless search of which I have spoken is made in order to avoid losing a fortunate opportunity for removing an easily accessible appendix which it would be a pity to leave behind.

Tube drainage is essential. A single tube, if well placed right to the bottom of the cavity, will be sufficient in an abscess of moderate size. When the cavity is very large, and when it extends upwards behind the ascending colon, sometimes to the liver and downwards into the pelvis, a large tube should be carried with forceps to the bottom of either extension, and the two will emerge side by side at the middle of the wound, under the anterior lip of which, and between the tubes, a layer of sterilized gauze will be lightly packed.

As a rule the wound should be left widely open: if, however, the cavity is not very large, if it has been well cleansed, if the appendix has been resected, and if good drainage is assured, one must nevertheless remember the comparative frequency of ventral hernia after iliac incisions, and it will be well at least to suture the extremities of the wound.

A large dressing secured by a broad flannel binder, prevented from slipping up by bands passed under the thighs, will complete the operation, which is, after all, a simple one, since it may be, and often is, limited to the incision of an iliac abscess.

II. But the situation is by no means always so simple, and the operator must be prepared to deal with other possible conditions.

And first amongst these, instead of finding an abscess lying directly under the abdominal wall, it may happen that **an adherent cæcum or thick mass of omentum is met with.**

The incision has been made as before, and, after having divided the skin, the aponeurosis, and the muscular plane, the greyish fibrous surface of the *fascia transversalis* is exposed; cut this carefully with the scalpel, or, better, raise up a fold of the membrane and open it with the scissors (*Fig.* 412); extend the incision upwards and downwards; the peritoneum now appears as a thickened, greyish layer of tissue, and nothing indicates the presence of a collection of pus immediately underneath; the finger, exploring the bottom of the wound continually in front of the knife, feels only an indefinite thickening, which may be firm and tense, or soft, irregular, and depressible.

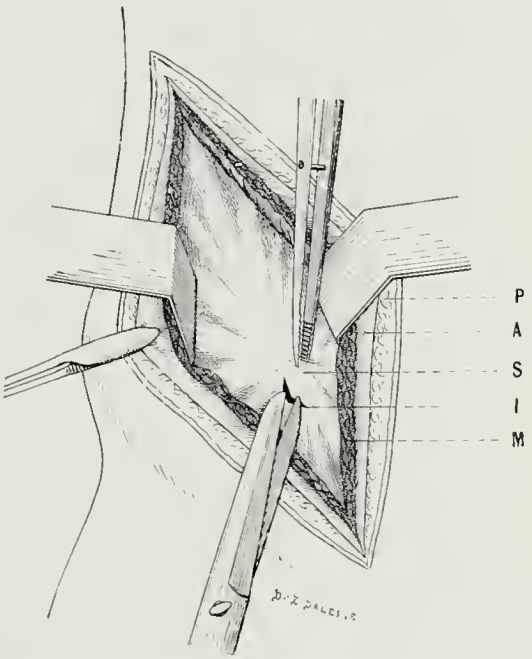


Fig. 412.—Operation for appendicitis. Incision of the transversalis fascia and peritoneum. (P) Skin. (A) Aponeurosis of external oblique. (S) Fold of the fascia raised with dissecting forceps. (I) Small opening in fascia. (M) Muscular layer.

Be careful; an adherent cæcum probably lies underneath, and the union with the parietal peritoneum is sometimes so close that this viscus has repeatedly been wounded or opened. Therefore choose a point where the peritoneum can be raised up a little, and *do not go far away from the iliac spine*: divide the raised-up fold with the points of the scissors, and, in completing the incision, be guided by a finger introduced through the opening to separate the adhesions; of course the peritoneal edges will at once be secured in the routine manner.

The wall of the cæcum is now seen in the wound; it is adherent to the parietal peritoneum, and is usually recognizable by its direction, its sacculations, and sometimes by its anterior longitudinal band; but do not spend much time in making out these details; when, in an operation for appendicitis, the incision has been made in a good position, if adherent intestine is met with on opening the peritoneum, that intestine is the cæcum, and **it is to the outer side of it, by raising and separating its outer border and posterior surface, that further searches must be pursued.**

At other times, and perhaps more frequently, after having opened the peritoneum with the precautions already indicated, there is found **a dense infiltrated mass of omentum** of varying thickness; here again keep to *the outer side*, follow the surface of the adherent omentum from within outwards with the finger, and begin to separate its external adhesions; usually in the course of this preliminary manœuvre the pus will begin to escape.

If any attempt is made to separate this mass of omentum in a haphazard fashion, it will probably be torn and caused to bleed badly, and there will be a risk of the operator losing his position. Therefore, let us again emphasize the necessity for raising it from **without inwards** (*Fig.* 413 and *Plate IX*), and for continuing the separation of the adhesions to the outer side of and behind the cæcum towards the deep-seated, indurated mass which can be felt. Most frequently it is in the position just mentioned, to the outer side of and behind the cæcum, that the abscess will be found, but the situation is somewhat variable, and if at the usual seat nothing is found but soft adhesions, continue the search, always following the cæcal wall, being guided by it, and carrying out the work of separation methodically, without haste or force.

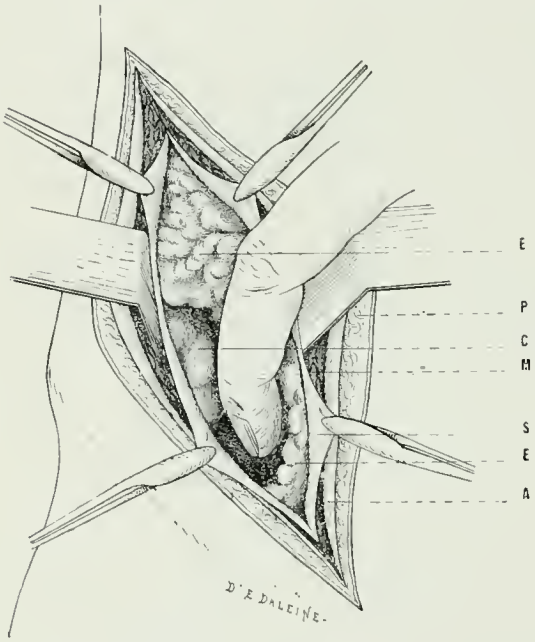
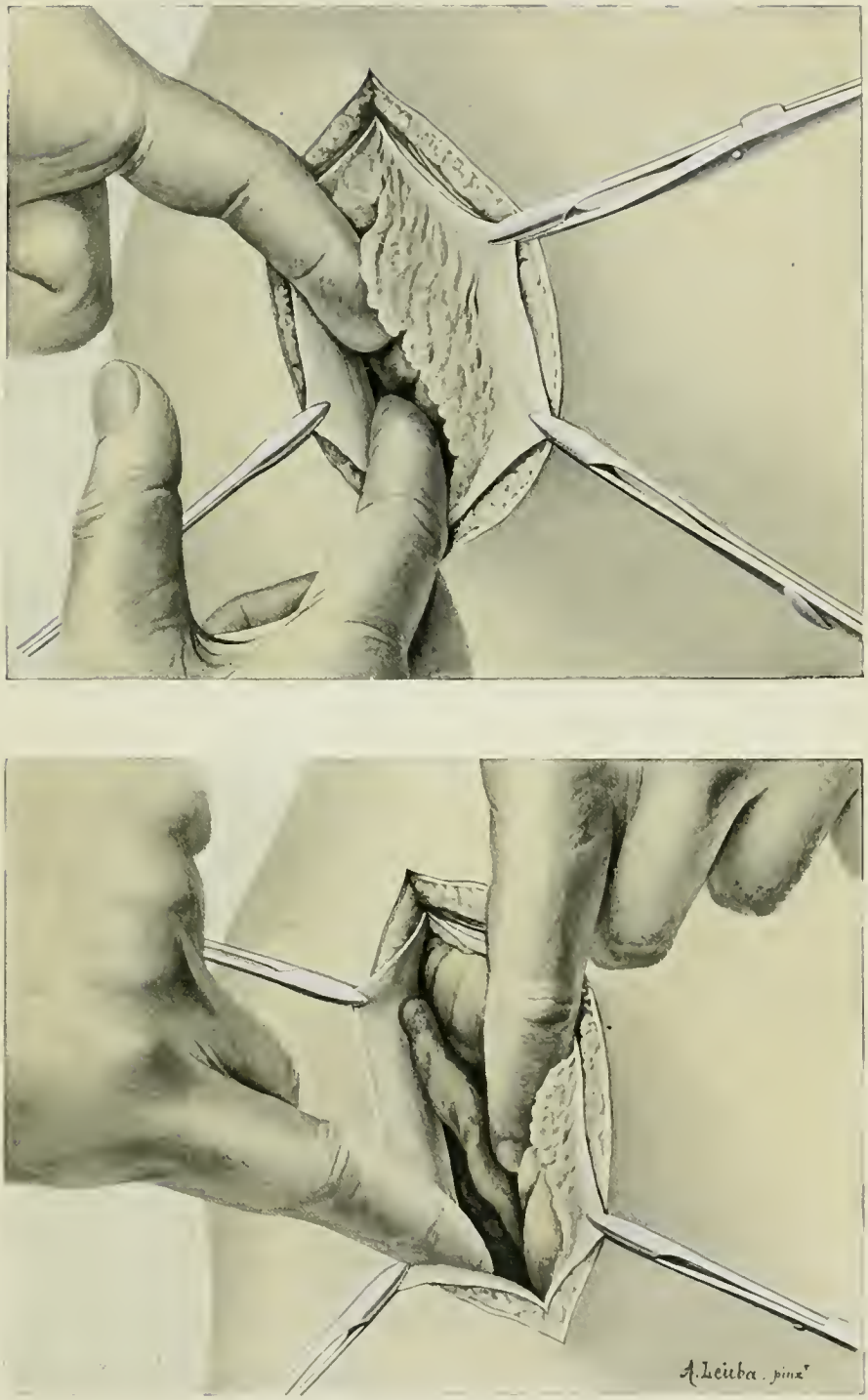


Fig. 413.—Operation for appendicitis. Separating the adherent omentum. (EE) Adherent omentum. (P) Skin. (C) Cæcum. (M) Muscular layer. (S) Peritoneum: (A) Aponeurosis of external oblique.

The inflammatory focus is sometimes situated *very high up, retrocolic* rather than *retrocæcal*, or even in the vicinity of the under surface of the liver, and by gradually ascending it will finally be reached. At other times *it is below*, towards the pelvis, or *inwards*, towards the sacral promontory, that one feels an indurated mass; follow, first of all, the outer surface of the blind end of the cæcum, then its posterior surface, so exploring the area in front of the sacro-iliac synchondrosis, in

Plate IX.—**Operation for Appendicitis.** The upper figure shows the separation and displacement of the omentum and the outer surface of the cæcum. In the lower figure, the laterocæcal abscess is opened; removal of the appendix, gangrenous at the tip.



OPERATION FOR APPENDICITIS

the direction of the ileocæcal angle ; it is in this region, below and internal to the blind end of the cæcum, that the approach to the pelvic or intra-cæcal foci will be found.

As soon as the abdominal wall has been incised, an aseptic compress is slipped under the anterior lip of the wound and spread over the cæcum or omentum (*Fig.* 423), and in proportion as those structures are separated the protecting compress is drawn over them ; another is slipped under the upper or lower angle of the opening according as the search is directed to one or the other end ; and moreover, while the work of separation is in progress, folds of gauze secured with forceps will be packed all round to cover and protect the various exposed planes and areas except that which is for the moment being dealt with.

The abscess is now reached ; it is opened after the rupture of some final adhesions, and often an extremely fœtid smell indicates the escape of the brownish, sanious pus. Cleanse the cavity with gauze swabs ; this is usually smaller than in the preceding variety, and is often divided into multiple pockets by incomplete partitions. With the finger gently break down any weak bands that run across the cavity, but do not interfere with any tense resistant septa.

Refrain from doing anything more ; provide good drainage and terminate the operation, the principal object of which has been achieved. Here again I content myself with saying that there is no reason why an effort should not be made to complete the operation by making a cautious search for the appendix, or at least by making sure that it is not lying quite close to the wound in a position whence it can be easily removed.

The localization of the appendix is very variable. We know that it is attached to the extremity of the cæcum, and that its insertion corresponds to the end of the anterior longitudinal band ; both these points are useful guides, but one must not forget that the actual position of the body of the organ varies greatly ; it is sometimes **laterocæcal,** and shows itself at once at the bottom of the cavity (*Plate IX*) ; more often it is **retrocæcal,** and ascends for an uncertain distance behind the cæcum, adherent to its posterior wall ; at other times it is **infracæcal,** and descends towards the pelvis, lying across the sacro-iliac synchondrosis ; lastly—and it is then that its exposure is attended with the greatest difficulties—it is hidden **to the inner side of the cæcum,** behind the termination of the ileum, or is lodged in the midst of the loops of small intestine which limit the focus on the inner side. It is particularly when the organ is situated in the last-mentioned position that persistent attempts to discover it entail serious risks without any compensating advantages.

One thing is certain : the appendix is always in relation, at some point, to the wall of the cavity just opened, or at least with one of the foci if there are several. Therefore cleanse and dry the walls of the abscess or abscesses with gauze swabs, and examine them carefully ; the appendix often appears in the form of a *thick reddish cord,* covered with granulations (*Fig.* 414) ; or again, it may show itself as a *nodular wrinkled mass,*

embedded in purulent lymph ; at other times it is *ruptured* towards its middle part, or *it may even be almost completely destroyed*, and one may find nothing but some unrecognizable débris ; on several occasions we have quite definitely found its area of attachment on the cæcum like a small cylindrical stump with ragged borders ; the organ had evidently been *detached en masse from its base.*

Fig. 414.—Resected appendix. (*a*) Body of the appendix. (*b*) Dilated extremity of the appendix containing a fæcal concretion. (*g*) Enlarged gland. (*p*) Meso-appendix.

To resume, if one is fortunate enough to recognize it quickly, then enucleate it gently with the finger, like an adherent tube, keeping very close to the appendix, liberating its extremity first of all, and continuing the separation steadily towards the base ; in doing this the thickened and friable meso-appendix will very probably be lacerated or torn ; the resulting hæmorrhage need, however, cause no concern ; a well-placed pair of forceps, or a swab firmly pressed down for a few seconds, will check it.

Take care *to free the appendix right to its cæcal attachment* in order to ligature it quite close to its base ; if it is fragmented, or breaks up during the manipulations, an effort must be made to find the little stump still attached to the cæcum, and to treat it in the way we shall immediately describe.

The appendix and its mesentery must now be ligatured, to do which proceed as follows :—

If the appendix has been satisfactorily liberated right up to its cæcal attachment ; if the mesentery is narrow and of average length, a loop of silk or catgut may be passed with an aneurysm needle or a pair of forceps through the serous membrane close to the base of the appendix, and both the appendix and the mesentery secured by means of Lawson Tait's knot (*Fig.* 415).

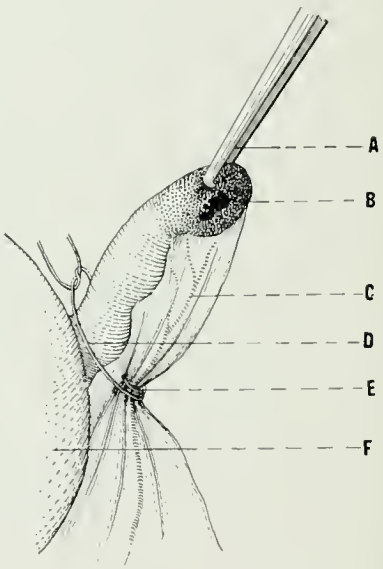


Fig. 415.—Ligation of the appendix and its mesentery. (A) Forceps raising up the appendix. (B) Gangrenous extremity of the appendix. (C) Mesentery. (D) Ligature of the appendix by the two ends of the thread brought around it. (E) Ligature of the mesentery (Lawson Tait's knot). (F) Cæcum.

It will often be found simpler, however, to pass a single thread and to tie the two ends firmly around the mesentery first, and then to bring them round the appendix to secure it in its turn with a double knot. The ligature around the appendix must always be tightened *slowly* and *steadily*, as the wall cuts very readily ; as a matter of fact, in certain cases any form of ligation becomes impossible for this reason (see later).

When the mesentery is thick and short, and the appendix consequently bound down, it will be found better *to seize the mesentery first of all with a pair of Kocher's forceps* and then divide it with scissors between the forceps and the appendix; in this way greater liberty of action is secured, and one is able to straighten out the appendix and to apply the ligature more closely to its base. The appendix and mesentery are tied separately.

Fig. 416. — Appendix ligated, sectioned, and cauterized. (A) Interlocking ligature of the appendix and its mesentery. (B) Central cavity of the appendicular stump after cauterization. (C) Divided mesentery.

Divide the appendix with the thermo-cautery, and then carefully destroy the mucous membrane in the stump by plunging the cautery point, at a dull red-heat, into its centre (*Fig.* 416).

This is the simplest technique, and very often in acute cases it is **the only method applicable**; it may at times, however, be modified as follows:—

1. If the wall of the appendix close to its base is not too much thickened and friable[1] — and time is not too pressing — it is a good plan to *invaginate* the cut surface of the appendix by means of a few fine catgut sutures bringing the lips together, serous surface to serous surface, and then to cover the stump with a fringe of omentum or under a fold of the cæcal wall.

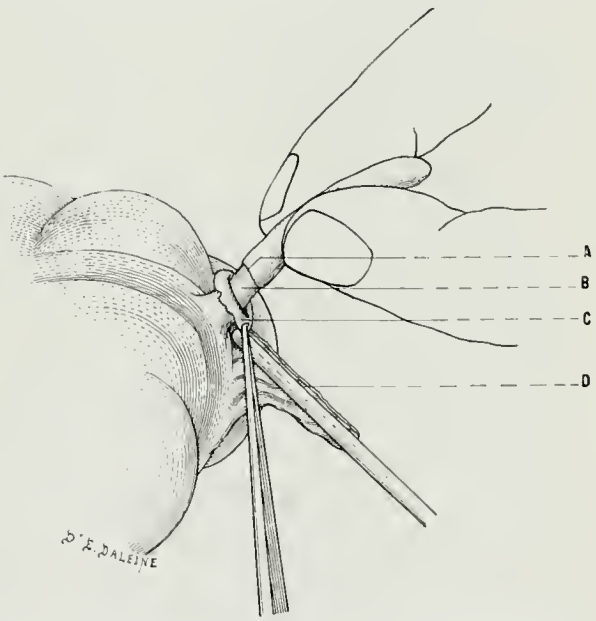


Fig. 417.—Resection of the appendix; circular section and reflection of the seromuscular sheath. (A) Section of the seromuscular coats. (B) Central musculo-mucous cylinder. (C) Seromuscular cuff turned back as far as the cæcum. (D) Cut edge of the mesentery, compressed by Kocher's forceps.

Or again, the following very attractive procedure may be adopted: incise the serous and outer muscular coats of the appendix circularly, about a third of an inch from the cæcum, and raise them like a cuff; they are lax and easily separable,[2] and can be readily turned towards the cæcal attachment (*Fig.* 417); ligature

[1] Because of this friability of the appendix, the excellent method of crushing the base, which is our routine practice in interval operations, is inapplicable to the cases of which we are now speaking.

[2] As a matter of fact, the separation occurs between the two muscular coats.

the central portion as high up as possible, divide it, destroy the protruding mucosa of the stump with the cautery or scrape it out with a small, sharp spoon (*Fig.* 418), then suture the lips of the little seromuscular cuff over it, serous surface to serous surface (*Fig.* 419), and bury the stump of the appendix and the ligated root of the mesentery under two folds of the cæcal wall (*Fig.* 420).

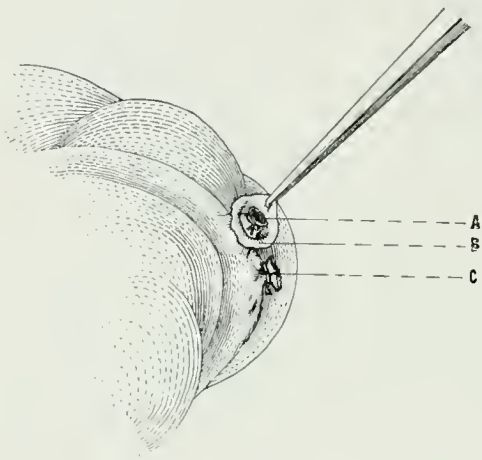


Fig. 418.—Resection of the appendix; the musculo-mucous cylinder ligated and cauterized; the seromuscular cuff. (A) Cut end of the musculo-mucous cylinder. (B) The seromuscular cuff turned back all round. (C) Ligature of the mesentery.

2. When the appendix is very adherent and its liberation is difficult, it is sometimes a good plan to begin the enucleation at the cæcal end, by dividing the base of the organ quite close to the cæcum between two forceps or two ligatures, and then continue it in the direction of the tip: this is known as "retrograde" enucleation (*Fig.* 421). In dealing with cases of this kind, M. Poncet[1] has recommended enucleation from within the serous coat: *subserous appendicectomy*.

After clamping and dividing the appendix close to the cæcum, the cut edge of the seromuscular coat on the distal end is seized with dissecting forceps and gradually worked back, and in this way one may succeed in enucleating the appendix from within its sheath.

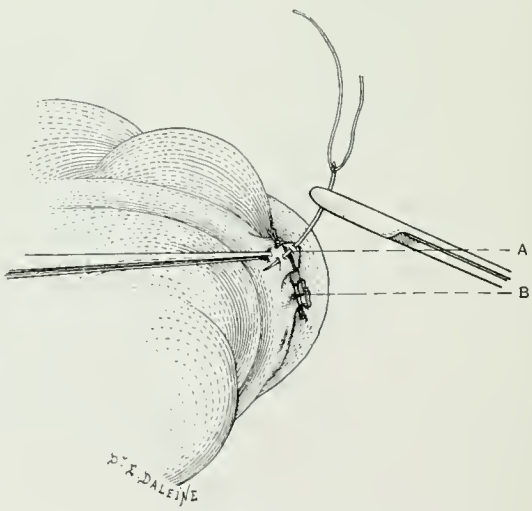


Fig. 419.—Resection of the appendix; suturing the cuff. (A) Uniting the edges of the cuff by Lembert sutures. (B) Ligature of the mesentery.

3. Finally, when the appendix is found ruptured or detached at the base, or if it cuts under the thread when an attempt is made to ligate it, the best plan is to push the short stump into the cæcum with a pair of dissecting forceps

[1] "De l'appendicectomie sous-séreuse," *Congrès de chirurgie*, 1899.

or a director, and to close the opening by bringing two folds of the cæcal wall over it by a series of Lembert sutures (*Fig.* 422).

Then complete the drying of the cavity; excise, after preliminary ligature, any infiltrated or torn fringes of omentum. If the cæcal wall has been lacerated, or its outer coats partially separated at any point, the lesion must be remedied as far as possible by some points of suture or by the reapplication of the little partially detached flap. Lastly, drain as before, suturing the extremities only of the wound.

III. The great advantage of the operations we have just described is that they can, and ought to, be carried out entirely within a closed area, the focus of appendicitis, shut off from the general peritoneal cavity by protecting adhesions which must not be destroyed. The general peritoneal cavity is not opened, and a favourable result is thereby to a large extent assured.

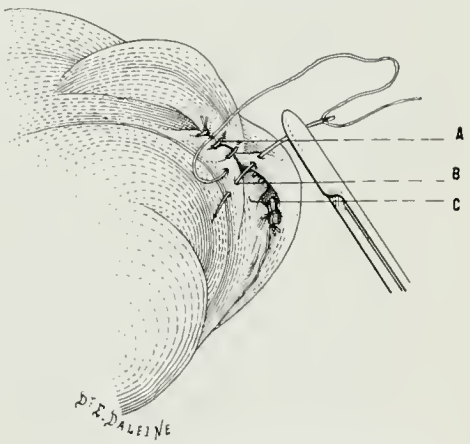


Fig. 420.—Resection of the appendix; burying the stump in the wall of the cæcum. (A) Bringing the folds of the cæcal wall together by a continuous suture. (B) The continuous suture opposite the stump of the appendix. (C) Ligature of the mesentery.

Therefore, when an abscess or an indurated mass has not been detected at the examination made prior to the operation, after the patient was anæsthetized, it is a good practice to repeat the examination before opening the peritoneum, after the aponeurotic and muscular layers of the abdominal wall have been incised. Seek for an indurated zone, or an area of thickening, and if found direct the attention towards it; if necessary, the posterior parietal peritoneum may be stripped up from the iliac fossa for a little way before opening it; do not, however, rely on being able to carry out the work satisfactorily by this indirect route without entering freely into the focus of inflammation, but it is still advisable to try to open the peritoneum within the area of that focus, that is, *within the adherent area.*

Notwithstanding these precautions, one may happen—and the occurrence is not uncommon—**to open the general peritoneal cavity at once**; behind, at some distance from the posterior edge of the incision, will be seen and felt the layer of adherent omentum, or the pericæcal swelling, of variable thickness and prominence, which indicates the position of the appendicular focus. By taking certain precautions the operation may be proceeded with. If the peritoneum is properly protected, there is nothing to fear from the effusion of pus. As soon as the peritoneum is opened, **slip an aseptic compress under its anterior edge** (*Fig.* 423), spread out the compress regularly along the whole length of the incision,

and for a few inches inwards under the abdominal wall; the hand of an assistant applied flat over the compress keeps it in position, and *so closes the entrance to the general cavity*. This precaution must be taken *at once*, because the abscess may burst and the pus escape as soon as the inflammatory mass is touched.

The pericæcal swelling is often covered by **a layer of omentum**: this layer is separated and turned back from without inwards in the manner we have already indicated (*Fig. 423*), and in its turn it is placed and retained under a compress; there will now be a barrier sufficient to protect the general cavity from infection. If, instead of omentum, the surgeon should first encounter the uncovered **cæcum**, some isolating compresses, properly placed and carefully kept in position, will enable him to carry out the subsequent steps without accident; but capable assistance is of great importance, because the septicity of these appendicular foci renders any mistake extremely dangerous, and entails very serious responsibility on the operator. After having in this way assured **the safety of the peritoneum**, the operation will be proceeded with as in the hypothesis we last considered. As soon as possible the abscess, if one exists, will be opened gradually, and the pus rapidly sponged up as it escapes; when the cavity has been in great part evacuated, the opening will be enlarged, the interior carefully dried out, and, if thought proper, a search made for the appendix. When everything is finished, the protecting compresses, the outer surfaces of which are soiled, are removed, and a fold of aseptic gauze is placed in the anterior part of the area. The rest is drained in the ordinary manner.

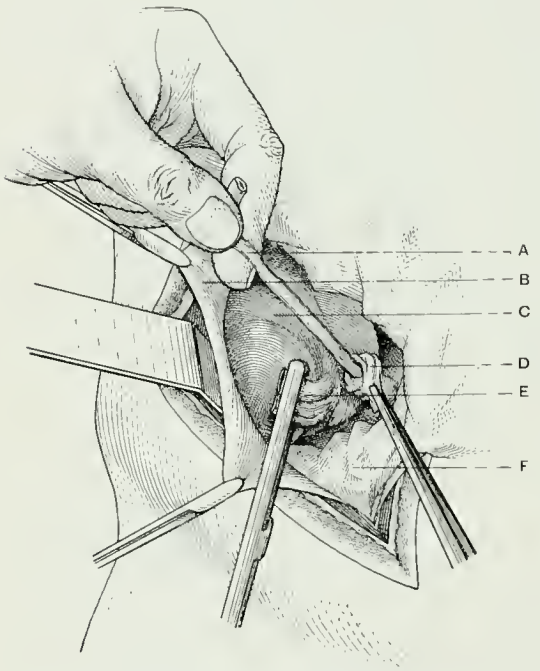


Fig. 421.—Sub-serous appendicectomy or retrograde enucleation of the appendix. (A) Appendix (musculo-mucous cylinder). (B) Parietal peritoneum. (C) Cæcum. (D) The retracted outer coat of the appendix. (E) The cæcal end of the appendix. (F) Protecting compress.

There is another and more uncommon condition which is sometimes met with when the operation is performed at an early stage. On incising the peritoneum, the free cavity is opened, no abscess or adherent iliac swelling is found, but below and to the outer side of the cæcum **a small mass surrounded by omentum** is seen; it is the appendix, thickened and

œdematous and on the way to perforation, but with no surrounding abscess. At other times a small latero-cæcal cavity is found, imperfectly shut off by fine adhesions, and in which the appendix appears, not yet perforated, but dark-coloured and distended, or yellowish-green and flaccid.

As before, an aseptic compress will be arranged to protect the general peritoneal cavity; the omental covering, if there is one, will be gently separated, and the appendix, after being drawn outside, will be ligatured and resected. The organ will be freed just like a suppurating tube, and care will be exercised to avoid rupturing it.

It is particularly in these simple cases that the appendix, if abnormally situated, may be found by following the longitudinal band of the cæcum; or the blind end of the cæcum may even be brought outside the wound to facilitate the search for the appendicular attachment. All these manœuvres must of course be very cautiously executed *within an area enclosed by protecting compresses.*

Lastly, when performed at a very early stage, within the first twenty-four hours, and there is neither pus nor any peri-appendicular inflammation, the operation is greatly simplified, and the technique applicable to interval cases may be employed; Jalaguier's incision may then be adopted with advantage; the various steps in the opening and the subsequent repair of the abdominal wall are shown in *Figs.* 424, 425, 426, 427.

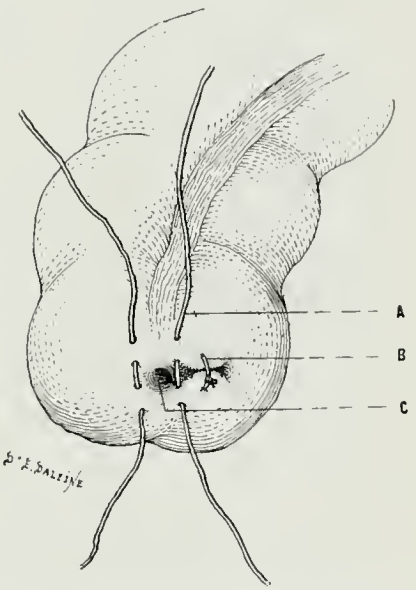


Fig. 422.—The stump of the appendix pushed into the cæcum; closure of the cæcal orifice. (A) Lembert sutures uniting the lips of the cæcal orifice. (B) A suture already tied. (C) Cæco-appendicular orifice.

IV. The situation is very different and the prognosis much more grave **when the incision opens into a free but already infected peritoneal cavity, in other words, when diffuse peritonitis is present.**

It is necessary, however, to make certain distinctions between the various kinds and degrees of peritoneal infection and the various lesions observed.

(*A*). **The inflammatory area is not closed on the inner side; it is bounded by loops of small intestine, attached to one another only by feeble and incomplete adhesions, and covered with patches of purulent lymph.** In short, the peritonitis is in process of diffusion, but it may not yet have extended very far.

The important practical question which arises in these cases is: should irrigation be employed? Irrigation will be attended by a considerable

risk of diffusing and spreading the infection. It is very much better to depend on careful drying out of the cavity and cleansing the neighbouring loops of bowel with gauze swabs, bearing in mind that as the patches of purulent lymph and false membrane are often very adherent, the intestinal wall may in consequence easily be seriously injured by too rough rubbing or too persistent attempts at their removal. Lastly, terminate the operation by providing multiple deep drainage.

(*B*). There may be **multiple purulent foci disseminated amongst the coils of small intestines**, more or less completely isolated one from the other by agglutination of the surrounding loops. This variety has been called **diffuse multilocular purulent peritonitis.**

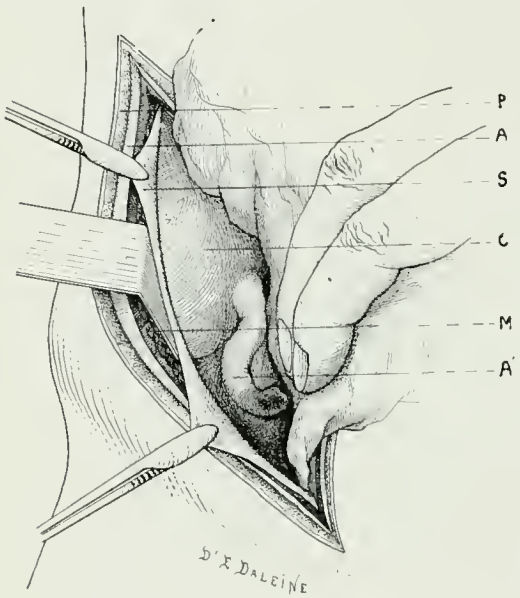


Fig. 423.—Operation for appendicitis. Placing the protecting compress under the anterior lip of the wound. (P) Skin. (A) Aponeurosis of the external oblique. (S) Peritoneum. (C) Cæcum. (M) Muscular layer. (A') Appendix.

After the evacuation of the pericæcal abscess, an endeavour must be made to separate the mass of adherent intestine which forms a species of tumour on the inner side of the cæcum ; separate the loops gently, open, empty and dry out the various purulent foci. and drain them.

(*C*). On making the iliac incision, **some brown, turbid, often fœtid fluid, which has been compared to dirty beef-tea,** escapes, and the intestinal loops are seen to be reddened and distended with scarcely any adhesions between them, and there is not the slightest trace of any limitation.

It is the most malignant irremediable form of peritoneal infection. When these conditions are present the prognosis is practically hopeless. What is to be done, however ? Irrigate the peritoneum freely, following the technique we shall immediately describe ; quickly remove the appendix, which usually, in these cases, presents itself without difficulty, as the perforation has taken place primarily into the free peritoneal cavity, and there are no adhesions to fix it ; drain the iliac fossæ and the pelvis, and turn to " irrigation of the blood " (copious saline infusion) as a last resource. The extreme gravity of these primarily generalized infections is due to the fact that they are always operated on too late, at a time when the septic poisoning is too far advanced for any possibility of recovery ; the period of curability is difficult to determine, but it is always very short, and a laparotomy performed during the hours

immediately following the inoculation of the peritoneum would alone have any chances of success.

(*D*). **Diffuse purulent peritonitis** is, in general, more hopeful, at least in young subjects whose vital resistance is not too much impaired. The proportion of recoveries is nowadays comparatively high.[1]

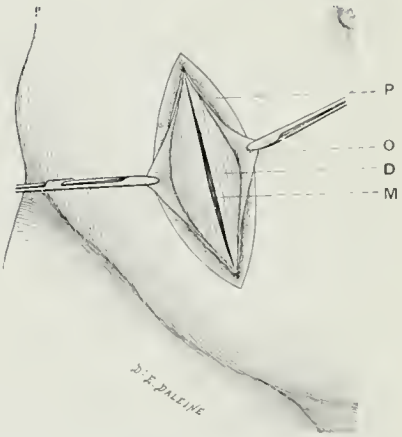


Fig. 424. — Resection of the appendix; Jalaguier's incision. (P) Skin and subcutaneous fatty tissue. (O) Aponeurosis of the external oblique divided and secured by forceps. (D) Anterior layer of the sheath of the rectus. (M) Rectus muscle.

Case 45.—A boy 16 years of age. The illness had begun suddenly in the night of March 18th, and we saw him on the 21st. His condition was then exceedingly bad; the face was pinched, vomiting of greenish matter was incessant, and the pulse was wretched; the abdomen was tense and distended, and the acute sensibility of its entire surface allowed no doubt as to the existence of diffuse peritonitis. I made first a right iliac incision, and opened into a focus of suppuration in the middle of which I found two fæcal concretions. The appendix was readily discovered behind and to the outer side of the cæcum; it was gangrenous and partially ruptured near its centre; it was liberated and resected. Meanwhile the pus continued to run in abundance from the deeper areas, and by raising the abdominal wall it was easy to see that the intestinal coils were completely bathed in the purulent fluid, and that there were no adhesions and not the slightest sign of any localization. I made a second median incision, and set myself to thoroughly irrigate the peritoneal cavity with sterile salt solution, continuing until the fluid returned perfectly clear. The irrigation brought out a very considerable quantity of pus, which came from all parts of the abdomen. Two large drainage tubes were placed in the iliac wound, another in the median incision, and the extremities of the wounds were sutured. During the following ten days or so, large quantities of saline solution were injected. The patient rapidly recovered his strength, and by June 4th was completely cured.

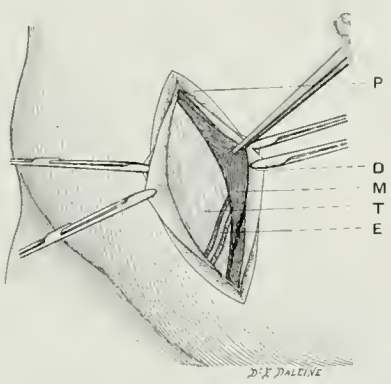


Fig. 425. — Resection of the appendix; Jalaguier's incision. The outer border of the rectus is separated and retracted inwards. (P) Skin and fat. (D) Anterior layer of the sheath of the rectus. (M) Rectus muscle retracted inwards. (T) Deep layer of the sheath of the rectus (fascia transversalis and parietal peritoneum.) (E) Epigastric vessels crossing the inferior angle of the wound.

[1] Demoulin, by collecting the statistics of Tuffier and Hallion, of Jacob, Guérin, and Richardson, in 1894, arrived at a total of 89 cases with 29 recoveries and 60 deaths, that is, a mortality of 66 per cent and recoveries 33 per cent (*Arch. gén. de méd.*, 1894, p. 70). The more recent statistics show a recovery rate of 45 and even 50 per cent.

Copious peritoneal irrigation appears to us to be always indicated in cases of this kind ;[1] but if it is to be of any use it must be abundant and as thorough as possible. The iliac route is insufficient by itself ; *a median incision* must be added to it, and perhaps even a *second iliac incision on the left side*. By this double or triple approach an efficient stream of fluid can be introduced which sweeps away the pus and carries the irrigation to all parts of the abdomen.

Boiled salt solution of a strength of 9–1000 is the best irrigation medium ; it can be obtained anywhere, its use is attended with no danger of poisoning, and as a certain quantity of the fluid is always absorbed, it

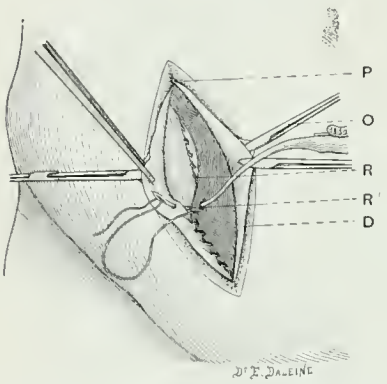


Fig. 426.—Resection of the appendix ; restoration of the wall after Jalaguier's incision. (P) Skin and fat. (O) Aponeurosis of the external oblique, secured by forceps. (R) Continuous suture uniting the deep fascio-peritoneal layer. (R') Suturing the outer margin of the rectus muscle to the outer angle of its fibrous sheath.[2] (D) Anterior layer of the sheath of the rectus.

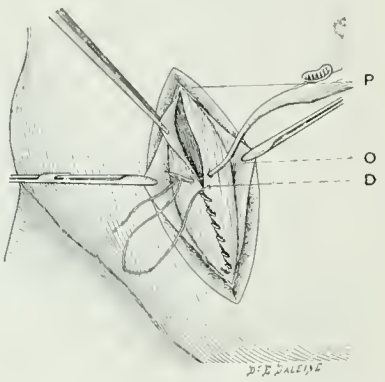


Fig. 427.— Resection of the appendix : restoration of the wall after Jalaguier's incision. (P) Skin and fat. (O) External aponeurosis. (D) Continuous suture uniting the cut edges of the anterior sheath of the rectus.

exercises a valuable restorative action ; usually indeed, during the course of the irrigation the pulse can be felt to improve. The solution must always be warm (101° F. to 102° F.). A glass reservoir[3] with a rubber tube and long glass cannula, all sterilized by boiling, constitutes the best form of apparatus ; the cannula is introduced at one opening after the other and moved about as much as possible amongst the intestinal coils, and the irrigation is continued until the fluid comes back perfectly clear. It is good practice to leave some of the solution in the abdomen.

[1] But only in cases of diffuse purulent peritonitis in which the intestines are bathed freely in the pus ; in cases of extensive suppuration with multiple foci, careful cleansing of the various cavities with gauze swabs is much to be preferred ; of course, after cleansing the different foci, adequate drainage must be provided, and in some cases assured by counter-openings. With the object of securing dependent drainage, it will sometimes be useful to combine with the median and lateral incisions, another in the lumbar region above the crest of the ilium at the outer border of the erector spinæ muscle, in the position where the perinephritic abscesses tend to point.

[2] A few interrupted sutures are quite sufficient when the rectus muscle is thick and broad.

[3] Or a large glass funnel, into which the solution is poured from a jug.

Good drainage must be provided ; a large tube is carried right to the bottom of Douglas' pouch and emerges at the lower angle of the median incision ; one or two other tubes are placed in the iliac fossæ. It is well to envelop each tube with a layer of gauze, but the wounds must not be packed with gauze, which would speedily become saturated and, by compressing the tubes, would interfere with the drainage. The wounds should be left widely open, only a few sutures being introduced at the extremities, to prevent the viscera from escaping.

Appendicitis in Abnormal Situations.—Thus far we have been considering cases where the appendicular focus occupies the right iliac fossa or regions in the immediate vicinity, and which may be exposed by means of the iliac incision, as we have described it, or slightly modified or extended. But an abscess of appendicular origin may exceptionally be found in a situation which necessitates an incision very far removed from the iliac region.

The swelling may be **median and subumbilical**, and we have already quoted an instance of this condition ; the diagnosis is then often difficult, and the lesion may easily be confused with one of pelvic origin. In such cases it is always advisable to have recourse to median laparotomy or to an incision at the outer border of the rectus muscle ; the uncertainty with regard to the diagnosis constitutes an additional reason for taking this course. When the abdomen is opened and the diagnosis established or confirmed, the measures for protecting the general peritoneal cavity which have already been detailed must receive attention before the inflammatory focus is dealt with.

We have also referred to **appendicitis with a left iliac abscess.** Naturally it is on the left side that the abscess will be opened and drained ; later, if the drainage track is slow in closing or persists as a fistula, a secondary operation may be performed under the more favourable interval conditions by the ordinary right-sided incision, for the purpose of removing the appendix or its remains.

In **pelvic appendicitis**, the abscess may be accessible by way of the iliac fossa, or on the other hand, it may be entirely contained within the pelvis and fail to show itself above Poupart's ligament by any swelling or thickening ; the incision, even when placed very low, then necessarily opens the general peritoneal cavity. The abscesses which are exclusively confined to the pelvic cavity lie in contact with the anterior wall of the rectum or the roof of the posterior vaginal fornix ; we have already pointed out the great similarity which they possess in female patients to suppurations of genital origin, and there can be no doubt that in a considerable number of emergency colpotomies (see later) the abscess opened has in reality been of appendicular origin. The pelvic route may be adopted in dealing with these cases ;[1] it permits only a simple incision of the accumulation

[1] Monod and Vanverts, "Du traitement des abcès pelviens d'origine appendiculaire. Avantages de l'incision vaginale." *Arch. gén. de méd.*, mai, 1898, p. 513. See also Lapointe, "Appendicite avec foyers péritoneaux à distance." *Presse méd.*, Oct. 10, 1900, p. 255.

of pus, but it has the advantages of being easily executed and providing dependent drainage ; the only necessary condition is that the vagina should be sufficiently wide. In the male, the prerectal incision, which we shall describe for dealing with an abscess of the prostate, used by Delanglade,[1] presents corresponding advantages and has similar indications. Lastly, one or the other of these two methods, colpotomy or prerectal incision, may with advantage be employed for drainage purposes in some cases where an abscess has been incised by the iliac route, but is too large or irregular to be satisfactorily drained in that direction.

The iliac incision, however, constitutes the method of choice ; if the pelvic swelling approaches Poupart's ligament at all, it should be dealt with by the abdominal route ; by the abdominal incision the work can be more satisfactorily completed, any diverticula or secondary pockets can be opened, and, if it presents itself, the appendix can be removed. The incision will be made parallel and *quite close* to Poupart's ligament ; when the parietal layer of the peritoneum is reached, if it allows itself to be picked up in a fold, and if its inner surface appears free from adhesions, then separate it with the finger from the iliac fossa from above downwards and from before backwards, till the position of the deep swelling is reached, and it will only be at that level and in an adherent zone that it will be opened. If the incision should open into the free peritoneal cavity, the operation will still be continued and the abscess opened after the precautions already described for the protection of the peritoneum have been rigorously observed. Lastly, very free drainage must be provided by means of two large tubes placed right to the bottom of the pelvic pocket.

At other times the abscesses present themselves **above the level of their usual situation**; they may be found in the **perirenal region, below the liver,** and even **behind and above the liver,** then forming a special variety of subphrenic abscess.

When the swelling occupies the kidney region, and projects backwards, or in the flank, it will be treated like any other perinephritic abscess by a lumbar or a lateral incision over the point where fluctuation has been detected, or over the most definitely accessible part of the deep mass. On two occasions we have opened, by a lumbar incision, acute perinephritic abscesses the appendicular origin of which was very definitely indicated by the brownish, fœtid pus, and by the downward prolongation of the cavity.

In another case the abscess was **prerenal,** and extended upwards to the under surface of the liver.

Case 46.—The patient was a young woman, 19 years of age, who a few days after having been delivered of a dead fœtus had begun to suffer pain, first of all in the right iliac fossa, then higher up below the liver. At the same time fever had appeared, and although the rest of the abdomen remained unaffected and the peritoneal reactions were very mild, the general

[1] Delangladf. *Bull. de la Soc. de chir.*, 1900, p. 604.

condition was still somewhat alarming, the pulse was fast, the face pale and a little drawn, the tongue dry. It was thought that the condition was a secondary perirenal abscess, and that the infection was of uterine origin.

In the *extreme upper part of the flank* a tense thick swelling could be felt which extended forwards to the outer border of the rectus and upwards as high as the liver. The mass was extremely tender and deeply fluctuating, and on bimanual palpation with one hand under the loin and the other on the flank, the fluctuation seemed to be transmitted backwards into the lumbar region.

The ordinary incision for a perinephritic abscess was made, but it soon became evident that the retrorenal space was unaffected, and that the inflammatory mass would be only reached with difficulty by that route. The wound was therefore closed, and a second incision made over the anterior prominence of the swelling. I opened into a cavity which was entirely adherent to the abdominal wall, was closed in all directions, and which contained a quantity of dark-coloured pus with a most characteristic intestinal odour. I contented myself with draining it. The patient recovered without any incident.

Lastly, these aberrant abscesses may be situated at a still higher level, in the region of the liver or the diaphragm; they may be **subhepatic, subphrenic, intrahepatic.**

Amongst these accumulations, some are **in direct continuity with the original appendicular focus,** of which they represent a more or less elongated diverticulum; a close examination of the walls of the cavity after the iliac incision will reveal their presence, and, by means of a sufficient enlargement of the primary wound, they may be emptied and drained by the same route.

The others belong to the group of *distant abscesses*, and require a special operation: an incision along the right costal border giving access to the subhepatic space; transpleural incision of the subphrenic or intrahepatic abscesses after resection of the 10th, 9th, or 8th rib, behind or in the axillary line.[1]

In Loison's patient[2] the condition was one of secondary intrahepatic suppuration; the first operation by iliac incision had been performed on October 11th, the abscess of the liver was opened on December 6th; it had made its appearance under the skin. An incision 4 inches long was made in the scapular line over the 10th rib, and a segment of the rib resected; the subcutaneous abscess communicated through the 9th and 10th intercostal spaces with a deep intrahepatic focus, the size of a hen's egg, containing greenish pus.

In other cases the perihepatic abscess exists alone, or at least it alone attracts attention; it is opened, and one then recognizes that it extends from above downwards and is of appendicular origin.

Jalaguier has recorded a very interesting instance of this condition in which he had to resect the 9th rib in order to reach the abscess cavity. "Immediately below the right costal border, and about three inches from the middle line, an area of fluctuation was discovered, but without any

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[1] See later, Hypochondriac Abscesses, Subphrenic Abscesses, Hepatic Abscesses.

[2] Loison, "Des suppurations intra- et péri-hépatiques d'origine typhlo-appendiculaire." *Revue de chirurgie*, avril, 1900, p. 523.

œdema or discoloration of the skin. Posteriorly, over the 8th intercostal space, I found another fluctuating point, and the fluctuation was quite definitely transmitted from the anterior to the posterior area. Behind, there was a moderate degree of œdema, but with no reddening of the skin.

"The illness had begun three weeks previously with a pain in the side, diffuse abdominal pains, and constipation. But from the evolution of the symptoms and the situation of the abscess it was thought that the condition was a purulent diaphragmatic pleurisy. The 9th rib was resected in the axillary line; it was then found necessary to incise the diaphragm in order to reach the abscess cavity; some gas escaped first, then a large quantity of thick, fœtid pus with a strong fæcal odour. After irrigation of the cavity it was found that the posterior wall was formed by the convex surface of the liver, and that the cavity extended downwards towards the iliac fossa along the ascending colon."[1]

Finally, we shall refer elsewhere to appendicitis in a hernial sac. (See STRANGULATED HERNIA).

PERITONITIS.

Numerous cases and everyday experience demonstrate incontestably that, in the presence of acute diffuse peritonitis, practically the only chance of recovery lies in an operation, performed in time. Taking into consideration the extreme complexity of the various "clinical situations," it is of importance to define first of all those elements which may serve as practical guides.

The gravity of a case of peritonitis depends on: (1) *The virulence of the infecting agent;* (2) *The extent of the peritoneal surface involved;* (3) *The interval which has elapsed from the time of infection.* In other words, it depends essentially on the amount of septic absorption. The degree of general toxæmia, and the evolution of the toxic process, result from multiple factors which are often in combination and, still more often, extremely difficult to estimate in advance. There is always something unknown, something irremediable, in each case: there are some forms in which death is inevitable, perhaps from the very first, certainly at the time when operation is performed; still, excluding some cases where a fatal ending is certain and imminent, we are never justified in pronouncing a hopeless prognosis on the evidence of the clinical phenomena alone.

Our course of action may be summarized in very simple terms: **evacuation of the effused septic fluid, drainage of the peritoneum,** and, if necessary, **the suppression of the original focus of infection.** Any idea of disinfection of the peritoneum in the strict sense of the word is, as Körte[2] has emphasized, impossible: it is futile to seek to destroy

[1] JALAGUIER, *Bull. de la Soc. de chir.*, 1 déc., 1897, p. 710.

[2] KÖRTE, "Die chirurgische Behandlung der Allgemeinen eitrigen Bauchfellenentzündung." *Arch. f. Chir.*, Bd. xliv., 3. p. 612.

the pathogenic agents on the surface and in the tissues of the great serous membrane, and it will be dangerous if, in striving to attain that illusory object, too energetic antiseptic agents and methods are employed. Here, as elsewhere, a cure is only possible by the vital reaction of the organism, and we can do nothing more than aid and support that reaction.

The vital question, therefore, always comes back to this: Is the patient still in a state to react? The answer must be in the negative once the septic intoxication is too profound: hence the positive indication for immediate operation as soon as the diagnosis is established. The infection increases hour by hour, and postponement till the morrow will often be equivalent to a death sentence. We can in nowise influence the causative microbic agent; we have no control over the anatomo-pathologic form of the peritonitis; there is therefore the greater reason for concentrating our efforts upon the single factor on which our action depends.

These general principles apply equally to all forms of peritonitis. We have already had occasion to speak of appendicular peritonitis; in another chapter we shall study peritonitis of hernial origin. Here we shall specially consider: (1) *Peritonitis from perforation* (*non-traumatic*); (2) *Puerperal peritonitis*; (3) *Pneumococcal peritonitis*.

I.—PERITONITIS FROM PERFORATION.

A woman, some 30 years of age, is attacked suddenly, shortly after a meal, with an acute pain in the abdomen; she collapses and drags herself to her bed, pale, cold, and in great distress; vomiting speedily supervenes and exaggerates her sufferings; the vomited matter at first consists of foodstuff, but soon becomes bilious and greenish, and sometimes, after a few hours, definitely fæculent.

A surgeon is called, and finds the patient still profoundly depressed, the face pinched, the pulse rapid and feeble, the extremities cold, and respiration difficult; from the onset of the symptoms there has been no movement of the bowels, no flatus has been passed and scarcely any urine. The abdomen is already considerably distended, tense, resonant almost to tympanism, and extremely sensitive to the slightest touch; no area of dullness or thickening can be discovered, and it is only recognized with difficulty that this superficial generalized pain is felt more deeply, more fixedly, and more intensely at some one or other point.

What is the diagnosis to be? **Peritonitis from perforation**, perforation of an ulcer of the stomach or duodenum, intestinal perforation in the course of ambulatory typhoid? Or, possibly, **hyperacute perforative appendicitis**? **An internal strangulation**? Or again, **sudden torsion of the pedicle** of a pelvic tumour, or **rupture of an intra-abdominal abscess**, the existence of which had been unsuspected? All these possibilities will present themselves at once to the mind of the observer, and further he must reserve a place for others which are unexpected, which do not at once occur to him, and cannot be foreseen.

Surprises are common in urgent abdominal surgery: sometimes they are inevitable, and one must recognize the absolute necessity for making a decision, without waiting for a precise diagnosis, which too often would only become definite when too late to be of any use.

I do not mean to say that a careful examination of the patient and a judicious analysis of his antecedents may not furnish sufficient evidence in favour of this or the other diagnosis; but there is often *something unknown* in cases of this kind; here, however, is no justification for delay, because the indications for immediate operative intervention are indisputable.

The *sudden onset*, followed by a condition of *shock*, the *extreme immediate gravity of the symptoms*, all agree in pointing to **peritonitis from perforation**; the localization of the initial and maximum pains, and the previous history, may supply further data.

The initial pain has been felt like a "stab"[1] in the epigastric region, and it is in that same region, or at least in the supra-umbilical zone, that the patient still feels the most pain and that the sensitiveness to touch is most acute; for some time the patient has suffered from pains after food, he has been treated for indigestion; or again, some months, perhaps even years, previously, he has vomited blood. The situation is becoming clearer, and one must think first of all of an **ulcer of the stomach** or of an **ulcer of the duodenum**; the latter is latent more often than the former, and the evidence less easily elicited in a hasty cross-examination.

I may add that in the case of a patient whose morbid history is well known, the diagnosis becomes very simple; the accident constitutes merely a well-recognized complication of the disease from which he has been suffering, and its possibility has been foreseen. But it is the obscure cases and those without previous history which interest us particularly.

As a matter of fact, the question ends in *an extremely probable diagnosis*, more than which we should not ask under the circumstances. **Gastro-intestinal perforation, appendicitis,** and **intestinal obstruction** are the three possible conditions which present themselves most often for discussion, and the early fæcal vomiting, to which Duplay long ago drew attention, comes as an additional factor to increase the resemblance between internal strangulation and peritonitis from perforation.

But practically, in either case *the indications are equally urgent*, and the primary steps of rational treatment are identical. Therefore, do not wait for more complete information, nor waste time over repeated examinations or useless medications which seriously imperil the patient's chances. There is acute peritoneal infection: that is enough to indicate the need for

[1] Professor Dieulafoy insists very strongly on the immediate intensity of this sudden, tearing, atrocious pain, actually like a "stab with a knife": further, it is localized at the onset and remains more acute in the subhepatico-gastric region above and a little to the right of the umbilicus. These characters distinguish it from the pain of appendicitis, which is gradually increasing, however sudden its onset may be. ("Perforation de l'ulcère simple de l'estomac." *Clin. méd. de l'Hôtel-Dieu*, 1897–1898.)

immediate operation, and the surgeon will only be freed from responsibility when it has been duly performed.[1]

Therefore, **operate at once,** after having taken the necessary precautions for protecting the patient during the course of the operation, which, further, should be made as short as possible (limbs enveloped with wool, well-warmed room, careful anæsthesia with ether, or local anæsthesia and, if necessary, preliminary injections of saline solution), and remember that operation has been attended with success in some cases which seemed absolutely hopeless.

Technique of Operation.—The incision will be made in the middle line; *above the umbilicus* if the distention is more marked in the supra-umbilical region and there are reasons for believing that the condition is due to a gastric or duodenal lesion; *below the umbilicus* in the more common case of an uncertain diagnosis; either incision will afterwards be extended if necessary, according to the lesions discovered and the operative necessities. The peritoneum must be opened cautiously, as in all cases where abdominal distention is present, although in cases of perforation the intestines will often be at a safe distance from the wall, being pushed back by the free gas, which escapes noisily as soon as the serous membrane is incised. With this gas, which is a valuable confirmatory sign of perforation, foodstuff will sometimes escape, curdled milk or grumous fluid with a sour smell, perhaps coloured with bile, mixed with the turbid or purulent peritonitic effusion. *The characters of the extravasation* often furnish useful information with regard to the seat of the perforation.

But the intraperitoneal fluid may present no special characters, the stomach may have been empty at the time when the perforation occurred, or again, the opening may be partially occluded because of its situation, by adhesions, or by the displacement of the liver, which, under the pressure of the free gas, may be applied like a cover (Guinard)[2] to the anterior surface of the stomach. Allow the first stream of fluid to escape, sponge up any lying at the bottom of the wound, then envelop the presenting intestinal loops with large compresses and displace them laterally; if any doubt remains as to the nature of the primary lesion, examine at once the cæcum and appendix and, in females, the uterine appendages. If nothing is found

[1] Mickulicz (*loc. cit.*) has shown that the operative prognosis in cases of perforated gastric ulcer is four times better when performed within the first twelve hours than at later stages. The general statistics which he gave are very instructive: he collected records of 35 laparotomies performed from 1885 to 1894 for perforated gastric ulcer; of this number there was only 1 recovery and 34 deaths, a mortality of 97·15 per cent: from 1894 to 1896, 68 operations with 32 recoveries and 36 deaths, the mortality had fallen to 52·94 per cent. In a collection of 387 cases of gastric perforation treated by operation up to the end of 1902, M. F. Brunner found 201 recoveries (52 per cent) and 186 deaths (48 per cent); the analysis of the records enabled him to conclude that the most favourable period is within the first eleven hours, the distention of the abdomen usually appearing at the end of that initial stage. (F. Brunner, "Das akut in die freie Bauchhöhle perforirende Magens und duodenal Geschwür." *Deutsche Zeits. f. Chir.*, 1903, lxix., p. 101). The results are much less satisfactory in so far as they relate to perforation of a duodenal ulcer. In 83 laparotomies collected by Brunner, there were 17 recoveries (20 per cent) and 66 deaths (80 per cent); this high mortality is due to the fact that in the duodenal cases the diagnosis is more difficult, and the condition is generally recognized and submitted to operation at a comparatively late stage.

[2] Guinard, "Ulcères perforants de l'estomac." *Congrès franç. de chirurgie*, 1898, p. 320.

in those regions,[1] return to the stomach and duodenum ; a fluid track may sometimes lead to the perforation.[2]

Be that as it may, raise the liver gently and *examine the anterior gastric wall :* according to Mickulicz, in 80 per cent of the cases the perforated ulcer is situated on the anterior wall, and most commonly *near to the pylorus* or *the lesser curvature ;* the opening is usually circular in shape and of variable size, sometimes large enough to admit a finger, and is surrounded, perhaps hidden, by flakes of lymph. A second perforation may be situated on the posterior wall in an exactly corresponding situation (*Fig.* 428). If you can see nothing on the anterior aspect, explore *the lesser curvature, the cardiac end,* and then inspect *the duodenum* ; there again a perforation is usually situated on the anterior surface and in the first part.[3]

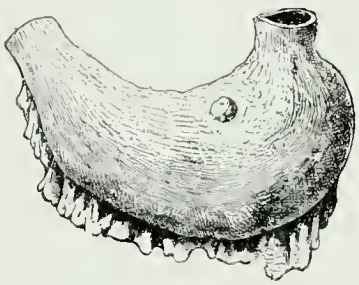

Fig. 428.—Double perforations of ulcers on anterior and posterior walls of stomach. (DIEULAFOY, *Clin. de l'Hôtel-Dieu*, 1897–1898, p. 89).

Commonly, some fluid and gas escape from the perforation[4] under the pressure of the hand during the examination, and serve to indicate its position. In a case of Sieur's[5] a bubbling noise was heard indicating the escape of gas, and some greenish fluid mixed with gas, similar to that which the patient had been vomiting, was seen running deeply towards the hilum of the liver. The discharge increased in quantity when pressure was applied to the stomach, and at last a perforation was discovered in the first part of the duodenum on its postero-superior surface. The opening was large enough to admit the tip of the little finger ; its borders were thin and irregular, and it gave issue to a stream of greenish fluid whenever the least pressure was exercised on the stomach.

Let us presume that the perforation has been found on the

[1] Or nothing sufficient to account for the intra-abdominal conditions. In the event of finding, for instance, an appendix not badly diseased and not gangrenous, one must not rest satisfied, without further exploration, that it is the actual cause of the trouble, even though the localization of the pain and the absence of any history indicating an affection of any other organ seemed to point to the appendix as the focus of inflammation. In one case I concluded that the appendix was the sole cause although it was not perforated, and at the autopsy some days later I found a ruptured ulcer on the anterior surface of the stomach.

[2] According to Auffray (*Contribution a l'étude de la péritonite suraiguë dans l'ulcère perforé de l'estomac.* Thèse de doct., 1898, No. 427), an ascending increase in the peritonitic lesions, which become more and more marked as the stomach is approached, may also serve as a guide.

[3] According to Collin, an ulcer of the duodenum in 242 cases out of 262 was situated in the first portion, less than two inches from the pylorus ; in 14 it occupied the descending portion ; in 3 that portion which lay in front of the aorta, and in 2 the ascending limb. Thèse de doct., 1894. *See also* DARRAS, *De la perforation dans l'ulcère simple du duodénum.* Thèse de doct., 1897, No. 536.

[4] And it is exactly for the purpose of avoiding these escapes of gastric contents that all the manipulations ought to be carried out gently and methodically.

[5] In Schwartz's paper, "Diagnostic et traitement des péritonites septiques, diffuses, produites par l'ulcère perforant du duodénum." *Société de chirurgie*, 5 jan., 1898.

stomach or duodenum : what is to be done ? Naturally the perforation must be closed, and without any operative complication or loss of time. If the borders are not too friable, the opening may be closed in the ordinary way by two rows of sutures, the deep row including the whole thickness of the walls and the superficial one approximating folds of the seromuscular coats. But often the simplest plan consists in infolding the perforated ulcer without trying to suture the edges ; some Lembert sutures of fine silk are passed in the gastric wall from one side to the other of the opening ; then, by tightening and knotting the threads, two seromuscular folds are raised and brought together (*Fig.* 429) ; if possible, it will be advisable to apply a second row of sutures over the first (*Fig.* 430).

Fig. 429.—Infolding of a perforated gastric ulcer. Suturing the two lateral folds together.

The gastric wall around the perforation is usually thickened and very friable ; be careful, therefore, to introduce the sutures at some distance from the margins ; tighten the first ones very gradually, at the same time pressing the adjacent portions of the wall together with the fingers : when they have been tied and the double fold is formed, they will —if gently pulled upon—assist the introduction of the others. Be careful to insert the second row of sutures in perfectly healthy tissue, even though, in order to do so, it is necessary to go some distance from the first suture line. If the base of the ulcer is very extensive and callous, it may be necessary to excise its borders rapidly, and to alter its outline, by elongating or making it oval for example, in order that its margins may be infolded and the neighbouring serous surfaces be brought into satisfactory contact. At or in the vicinity of the pylorus, it is inadvisable to close the opening in a line parallel to the long axis of the canal, or stenosis might result. Whatever the shape of the perforation may be, whether its margins are freshened or not, it must be sutured transversely, or at any rate obliquely to the axis of the canal (*Fig.* 431). Lastly, for additional security, a fold of omentum may be placed in front of the sutured perforation, and fixed by a few interrupted sutures (*Fig.* 432).

Fig. 430.—Infolding of a perforated gastric ulcer. The second row of sutures.

Sometimes it happens that the gastric or duodenal wall around the orifice is so extremely friable that it cuts under the threads and, in spite of the greatest care, renders closure impossible.

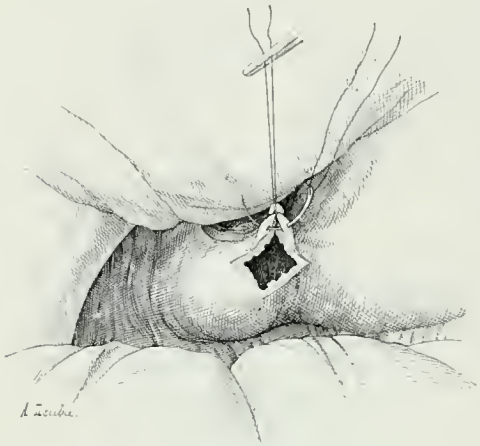

Fig. 431.—Perforated ulcer in the pyloric region. The margins have been excised; the opening is being closed at right angles to the long axis of the canal.

What can be done then? If the condition of the patient permits, one may perform an extensive lozenge-shaped resection including the whole of the diseased area, and suture the margins together transversely to the long axis of the organ;[1] but as a rule any such procedure is out of the question, and one must of necessity be content with certain methods which are undoubtedly precarious but are the only ones available.

The best procedure is to endeavour to isolate the region where the perforation is situated. Turn the lower margin of the great omentum upwards in front of the perforated area and suture it to the anterior surface of the stomach or duodenum, as the case may be; in this way the orifice may be closed, at least mechanically; then try to shut the area off from the rest of the peritoneal cavity by suturing the omentum all around it to the stomach and to the parietal peritoneum, and leave a large drainage tube surrounded by layers of aseptic gauze in the cavity thus limited, until adhesions complete the closure.[2]

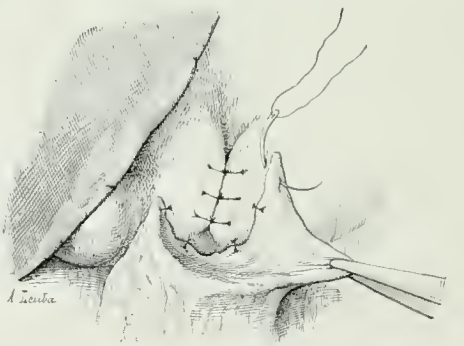

Fig. 432.—Perforated ulcer of the stomach. A fold of omentum has been in part fixed around the sutured area, and is about to be spread out in front of it.

[1] At the lesser curvature, where invagination is often very difficult, the ulcer may sometimes be excised between two pairs of forceps, and the edges sutured in the manner shown in *Fig.* 359.

[2] Gastro-enterostomy (posterior) is a very valuable additional measure, if it can be performed quickly by a practised hand; it is particularly indicated when, in addition to the perforated ulcer, the pylorus is hard, thickened, and callous; or again, when the perforation has been very large and its margins friable, and has only been very unsatisfactorily sutured. In 19 laparotomies for perforated ulcer, M. Körte has on nine occasions performed a complementary gastro-enterostomy, and of these 9 patients 7 recovered. (Körte, "Beitrag zur Operation der perforirten Magengeschwüre." *Arch. f. klin. Chir.*, 1906, lxxxi., 1, p. 83.)

But possibly **nothing may be found on the stomach or duodenum**: the perforation may have occurred on the posterior surface into the lesser sac of the peritoneum; that region must therefore be explored in the manner we have described elsewhere (see HÆMORRHAGE FROM ULCER OF THE STOMACH OR DUODENUM) by means of an opening made in the gastrocolic omentum between the great curvature and the transverse colon, the latter being displaced downwards under a compress (*Fig.* 433); this exploration is, under the circumstances, always difficult and dangerous.

CASE 47.—A woman, 25 years of age, was brought to the hospital suffering from general peritonitis: abdomen distended and everywhere sensitive, vomiting of brownish material, pulse 140, tongue red and dry, facies bad; the symptoms were of four days' duration; they had begun suddenly, but it was impossible to get any definite information with regard to primary localization of the pain; all that we could learn was that the patient had formerly vomited blood and had suffered from a "pain in the stomach and back." Laparotomy was performed forthwith; a great quantity of greyish pus was found in the pelvis and between the coils of intestine; the appendix was examined and was found to be healthy; the median incision was then extended into the supra-umbilical region; the stomach was situated very high up, and the appearance of its anterior surface was normal, there was nothing abnormal at the pylorus or under the liver. An opening was torn in the gastrocolic omentum for the purpose of exploring the lesser peritoneal sac; the cavity was found full of purulent fluid, and its wall lined with yellow lymph; the track of the fluid was followed upwards and to the left to behind the cardiac end of the stomach, but we failed to find the perforation. The margins of the opening in the gastrocolic omentum were sutured to the parietal peritoneum, so marsupializing the lesser sac, which was drained by two large tubes; the general peritoneal cavity was irrigated with warm saline solution, and the pelvis drained. The patient lived for four days; the peritonitic symptoms had subsided and the abdomen was flat and insensitive; the cause of death was a double broncho-pneumonia; at the autopsy a small, punched-out perforation was discovered on the posterior surface of the pylorus, quite close to the duodenum.

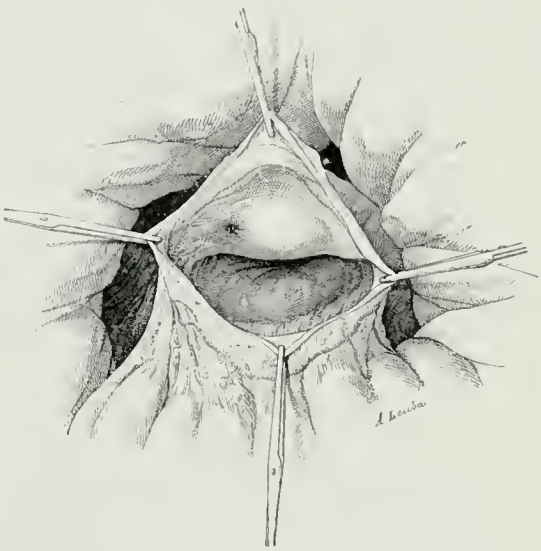

Fig. 433.—Perforated ulcer on the posterior surface of the stomach.

The perforation may be situated lower down in **the intestine.** We know that apart even from typhoid fever, to which we shall presently return, the intestine may be the seat of *perforating ulcers* of various characters, due to tuberculosis, to erosion by certain foreign bodies, to

gastro-intestinal uræmia. These acute perforations of the small intestine have been studied by M. Letulle,[1] while MM. Kirmisson[2] and Monod[3] have reported cases.

In the case of Kirmisson's patient, a child of 8 years, "as soon as the peritoneum was opened, a stream of greyish, purulent fluid with a fæcal odour escaped. A congested and distended loop also issued through the wound. By following the small intestine, a whitish, flattened loop was reached which was somewhat narrowed as if it had been submitted to some constriction. By the exercise of a little gentle traction, the whole of this loop was drawn outside, and in its upper part, at the junction of the dilated and narrowed portions, a small perforation was discovered close to the mesenteric border; it was in the form of a little reddish nodule, and intestinal fluid was escaping from it. The perforation was closed by a double row of sutures of fine carbolic silk. The intestinal wall was somewhat infiltrated and friable, and during the course of the suturing a hæmatoma developed in the tissues at the mesenteric border." After irrigation of the peritoneal cavity, an iodoform gauze drain was placed in position and the abdominal wound partly closed. Recovery ensued without any complication except a slight fæcal discharge which persisted for about a fortnight. Therefore keep **intestinal perforations** in mind and explore the **ileocæcal region,** where they are most often situated; then follow the small intestine upwards; sometimes a collapsed loop of unusual appearance, or a slender trickle of intestinal fluid, may serve as a guide. Never forget to examine the left iliac fossa and the **sigmoid colon**; the latter may be the seat of a diverticular perforation.[4] Once the perforation

[1] Letulle, "Des perforations aiguës de l'intestin grêle." *Presse médicale*, 1895, No. 18, p. 137.—Combes, *Des ulcères simples de l'intestin*. Thèse de Toulouse, 1897. R. Oppenheim and Ch. Laubry have reported two cases of peritonitis from perforation in the course of tuberculous enteritis; both ended in rapid death: in one only of the two cases was operation performed, but the perforation was not found. In both cases the lesion was in the terminal portion of the ileum, close to the cæcum; it was quite small, circular, and in the second patient the size of the head of a pin, "partly hidden by a flake of lymph," and it occupied the centre of an ulcer. ("La péritonite aigue par perforation au cours de l'entérite tuberculeuse." *Arch. gén. de méd.*, juin, 1899, p. 641). We have seen a patient die under quite similar conditions, and the case is worthy of being briefly reported: he was a man some forty years of age, on whom two months before I had performed an enterostomy for acute obstruction; all the abdominal symptoms subsided, and I closed the fistula by lateral enterorrhaphy. Everything went on satisfactorily during the first two days; on the morning of the third day I found my patient dying, with all the signs of peritonitis from perforation so far advanced that any operation appeared to me to be useless. At the autopsy the pelvis was found full of intestinal contents, which had come from a perforation in a tuberculous plaque situated low down in the sigmoid colon. No other similar plaques were found in the rest of the intestine. These tuberculous perforations, therefore, almost always occur unexpectedly, their discovery is often difficult during operation, and their occlusion is also difficult; it involves as an essential preliminary the excision of the entire tuberculous patch.

[2] Kirmisson. "Péritonite par perforation prise pour une appendicite: laparotomie médiane; guérison." *Bull. de la Soc. de chir.*, 14 mars, 1898, p. 279.

[3] Monod, "Perforations spontanées ou de cause inconnue de l'intestin simulant parfois l'appendicite." *Bull. de la Soc. de chir.*, 23 mars, 1898, p. 297.

[4] These perforations occur in the diverticula, sometimes scarcely visible, at other times the size of a hazel-nut or even larger, which are fairly often present in the wall of the sigmoid colon and which usually protrude into the bases of the appendices epiploicæ. Chronic constipation plays an important part in their causation. Some cases of suppurative perisigmoiditis originate in these diverticula, and by perforation they may be the cause of diffuse peritonitis. Telling has collected 14 cases. (W. H. Maxwell Telling, "Acquired Diverticula of the Sigmoid Flexure, considered especially in relation to secondary pathological processes and their clinical symptoms," *Lancet*, March 21 and 28, 1908.

is found it will be securely closed by Lembert sutures after the friable and necrotic borders have been excised if necessary.

The perforation is not always in the alimentary tract, stomach, or intestine; it may affect the *urinary bladder* (see above) or the *gall-bladder*, and these more exceptional occurrences must be kept in mind. In the latter case the condition may be due either to a rupture occurring during the course of suppurative cholecystitis, or to slow erosion of the wall by a gall-stone. A case reported by Hochenegg may serve as an example: a woman 45 years of age had been suffering for twelve hours with symptoms of intestinal obstruction; the abdomen was opened by a median incision below the umbilicus, and the transverse colon was found distended and prolapsed. The wound was enlarged, and, on freeing the colon, about 4 pints of yellowish-green serous fluid escaped from the upper part of the abdomen. The track of the fluid was followed upwards towards the gall-bladder, in about the middle of which a perforation 1 cm. long and ½ cm. broad, partially obstructed by a calculus, was found; the remainder of the vesicular wall was normal and not adherent. The fundus of the gall-bladder was incised, and seven calculi, each about the size of a hazel-nut, were extracted; the perforation was sutured after excision of the edges, and a cholecystostomy performed. The patient recovered.[1]

Ruptures of a **pyosalpinx** or of a suppurating **ovarian cyst**, though decidedly uncommon, require to be mentioned.[2]

Case 48.—A woman, 48 years of age, was admitted one evening into my hospital service with all the signs of diffuse peritonitis: pinched face, pulse 130 and feeble, distention and universal tenderness of the abdomen; on vaginal examination, a soft, semi-fluctuating, ill-defined mass was felt behind the uterus; nothing definite could be learned with regard to the onset of the illness, which had begun eight days previously. Laparotomy was at once performed by M. Guénot; pus was found in the pelvis, and amongst the reddened loops of intestine as high as the umbilicus; on the right side a large but intact pyosalpinx was found; on the left there was another pus-tube, but it was collapsed, and there was a large perforation on its postero-superior surface. Both tubes were removed, the pelvis and intestines were cleansed with warm saline solution, two drainage tubes with a mesh of gauze were placed in Douglas' pouch, and two other tubes in the iliac fossæ. The patient recovered.

In addition to these ruptures of large pus-containing tubes, it is well to bear in mind a variety of salpingitis in which gangrene and primary perforation occur, and of which I have reported several cases.[3]

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[1] J. Hochenegg, "Ein Fall von Perforation der Gallenblase in die freie Bauchhöhle, geheilt durch Operation," *Wiener klin. Woch.*, 1899, No. 21, p. 565. In a patient of M. von Mosetig-Moorhof, the symptoms had simulated appendicitis, but the appendix was found to be healthy; while the omentum was being raised some serous fluid mixed with pus escaped, and with it also a gall-stone the size of a hazel-nut; the gall-bladder was found to be perforated on its under surface, and a second calculus was engaged in the perforation, while five others remained in the cavity. Extraction of the calculi, cholecystostomy, recovery. *Wiener med. Presse*, Feb. 16, 1902.

[2] See H. Fossard, *Rupture spontanée des kystes de l'ovaire.* Thèse de Paris, 1901.

[3] "Note sur les salpingites perforantes," *Soc. d'obst., de gyn. et de pædiatrie*, fev., 1905, p. 22.

When dealing with a ruptured ovarian cyst or pyosalpinx, removal of the sac or tube is an essential step in the operation ; it will only be when adhesions are very extensive, and it is urgently necessary to get the operation finished quickly, that treatment may be limited to a partial excision combined with marsupialization or packing.

Lastly, the cases must be foreseen in which **no perforation can be found** ; nothing then can be done but terminate the operation (and the necessity for finishing quickly often seriously curtails the search) by the cleansing and drainage we shall describe presently.

The issue then becomes exceedingly doubtful, and the patient's chances of recovery are seriously compromised ; however, as Mickulicz has pointed out, recovery may sometimes occur contrary to all expectation, and I have myself seen such a case.

Case 49.—A woman, 40 years of age, was sent to me with grave symptoms of diffuse peritonitis ; the abdomen was greatly distended, and exceedingly sensitive to the slightest pressure over its entire surface ; there was vomiting of greenish material ; the pulse was 120, feeble and soft, and the face was pinched. The onset had occurred four or five days previously, and had been characterized by sudden pain in the umbilical region and vomiting ; some remission of the symptoms had appeared at the end of the first twenty-four hours, but since the previous evening the condition had visibly become worse. I operated at once, thinking of appendicitis, gastric or duodenal perforation, or possibly a peritonitis of duodenal origin ; but without any definite ideas owing to the lack of definite signs. I opened the abdomen by a median incision below the umbilicus, and found a large quantity of yellowish, almost odourless pus, diffused throughout the cavity. After evacuating the pus, I exposed the appendix without any trouble, and found it perfectly healthy ; I examined the intestine and the uterine appendages and found them likewise healthy ; I extended the incision above the umbilicus and found nothing abnormal in the stomach ; I therefore washed out the peritoneal cavity with warm saline solution, put in two suprapubic drainage tubes, and above them a mesh of aseptic gauze. The patient was in a very collapsed condition after the operation, but nevertheless recovered completely without the slightest complication ; a year later she remained perfectly well. Perhaps in such cases there is a small perforation, already closed or plugged by a shred of lymph ; be that as it may, one must always be suspicious, and drain freely.

Typhoid Perforations require special mention. Clinically they may present themselves in two ways :—

1. *Knowing little or nothing regarding the previous state of the patient,* one makes a diagnosis of diffuse perforative peritonitis, and in the course of the operation discovers one or several perforations of the ileum or the cæcum, the appearance of which leaves no doubt as to their nature ; for example :—

Case 50.—A boy, 12 years of age, who had been ill and confined to bed for about ten days, was brought to hospital in a very serious condition with all the signs of diffuse peritonitis ; the abdomen was greatly distended and dull in the entire subumbilical region ; the pain was diffuse, without any predominance in the right iliac region.

Without being able to form any definite idea as to the origin of the peritonitis, I performed laparotomy, and found a great quantity of seropus filling the

true pelvis and the iliac fossæ. The cæcum and appendix were healthy; but in the small intestine, approximately about the middle of the ileum, I discovered without much trouble—the adhesions being still scanty and soft—a definitely circular perforation of the diameter of the little finger, surrounded by thin, clean-cut borders, and occupying the centre of a dark red-coloured patch; on again examining the terminal part of the ileum, I found a series of similar patches, but without any other perforation. After excision of the margins of the perforation, it was closed in two layers with sutures of fine silk. The child died next day.

2. *In a patient under treatment for typhoid fever,* an acute pain at some point of the abdomen, a sudden rise or fall in the temperature, rapidly increasing abdominal distention, progressively increasing rapidity and enfeeblement of the pulse, and a pinched face, indicate the occurrence of perforation, and operation is performed in full cognizance of the cause.

It is this second condition that we wish particularly to discuss. Let us quote two cases:—

Case 51.—A man, 24 years of age, had been under treatment in M. Fernet's service for severe typhoid fever from November 20, 1895; on December 1, about 7 p.m., he complained suddenly of an acute pain in the right iliac region; the temperature, which had been 101·6° at 3 p.m. and 101° at 6 p.m., had risen to 104° by 9 p.m. Next morning, the face was definitely peritonitic, the pulse 120, and very feeble; the abdomen was not distended, but pressure caused intense pain, particularly in the right iliac region. There had been no vomiting, and the temperature was 97·6°. M. Fernet made a diagnosis of intestinal perforation, and I performed laparotomy at 11 a.m. On opening the abdomen, I found a considerable quantity of serous fluid, mixed with partly digested milk, in the pelvis and the right iliac fossa; after evacuating this fluid, I looked for the cæcum; it was intact, as was also the appendix. I proceeded to inspect the small intestine from below upwards, and at about 8 inches from the cæcum, on the convex border of the ileum, I found a circular perforation with well-defined borders, about the diameter of the tip of the index finger, and from which the yellowish liquid contents of the intestine were escaping. I excised the margins of the opening and closed it by five Lembert sutures of fine silk. The peritoneal cavity was cleansed by dry wiping, and drained. Under the influence of injections of saline solution, the patient improved at first, and we began to have some hope of his recovery; but the improvement was not continued, and he died on December 4. At the post-mortem examination no other perforations were found.

The other case also, in spite of ultimate failure, left us with the conviction that operation ought always to be attempted.

Case 52.—The patient was an unfortunate student on whom I operated in Professor Chantemesse's service in January, 1900; the attack of typhoid fever was very severe, and the signs of perforation dated from the previous evening. The pulse was 130 and very small, the extremities cold, the tongue dry and brown; the abdomen was distended and painful, particularly in the right sub-umbilical region, and respiration was laboured; the situation allowed of no delusions as to its gravity, and it seemed scarcely justifiable to attempt operation. However, I wished to do all I could for the poor lad. He was carefully anæsthetized, some salt solution was injected subcutaneously, and I opened the abdomen in the middle line below the umbilicus; a stream of blackish fœtid pus escaped at once; it seemed to come from all parts of the abdomen, but particularly from the right iliac fossa; in that region the intestinal coils were all covered with purulent lymph, but were only slightly

adherent, and by following one of them which was more congested and more thickened than the others I found, almost at once, a rounded perforation with lacerated borders from which fæcal material was escaping. It was situated on the free border of the ileum about 8 inches from the cæcum. After having placed the affected loop under a compress and wiped out the lower part of the abdominal cavity, I made sure that the appendix was intact and that the cæcum and the neighbouring intestine presented no sign of any other solution of continuity.

The perforation was closed by a double continuous suture of fine silk, and after having passed two gallons of very warm boiled water through the peritoneal cavity, two drainage tubes were placed in the iliac fossa and the pelvis, and the extremities of the abdominal incision sutured.

The whole proceeding had lasted half an hour, and the patient had borne the operation perfectly; the pulse recovered its force and became less frequent, consciousness returned, and the afternoon passed favourably. It was only a transitory improvement, however, and death occurred during the night.

Here again, it is not the operation which is fatal, and when we see patients so deeply infected, indeed almost moribund, show such powers of resistance, are we not justified in thinking that if operation had been performed earlier they might have been saved?

This belief has indeed been realized, and although the proportion of operative recoveries is still low, their actual number is sufficient to establish the legitimacy and urgent necessity of the operation.[1]

Let us take as examples the two cases of Loison[2] and Legueu.[3] M. Loison's patient, a soldier 24 years of age, was taken suddenly, on the sixteenth day of an attack of typhoid fever, with acute pain in the right iliac fossa; the pulse rose from 90 to 120; signs of peritonitis became evident: rigidity of the abdominal wall and acute tenderness in the whole of the sub-umbilical region. Laparotomy was performed fifteen hours after the appearance of the symptoms of perforation; a large quantity of dirty

[1] I had collected in 1896 (*Presse médicale*, 1 juillet, 1896, and *Société de chirurgie*, 26 nov., 1896) including my first operations, 25 cases with 6 recoveries, of which only 3 appeared to be indisputable. MM. Monod and Vanverts ("Du traitement chirurgical des péritonites par perforation dans la fièvre typhoïde." *Revue de chir.*, 10 mars, 1897, p. 169, *Société de Chirurgie*, 18 nov., 1896) had carried this number to 27 with 4 recoveries. Mauger in his thesis (*La perforation typhique de l'intestin et de ses annexes; son traitment chirurgical*. Thèse de doct., 1900) recounted 107 operations with 25 recoveries. Keen's two sets of statistics ("Surgical complications and sequelæ of typhoid fever," Philad., 1898, and *Journ. of the American Med. Assoc.*, 20 Jan., 1900) together include 158 cases, of which 37 were successful. MM. Harte and Ashhurst ("Intestinal perforation in typhoid fever." *Annals of Surgery*, Jan., 1904) have collected the records of 362 cases of operation for typhoid perforations with 26 per cent of recoveries. M. Zesas ("Ueber die Resultate der chirurgischen Therapie der typhösen Perforations Peritonitis." *Wiener Klinik*, Nov., 1904) in 255 cases found 95 recoveries (37 per cent); but all these statistics include the whole of the cases, irrespective of the type of peritonitis (localized or not) and the severity of the typhoid infection. Those, however, which Michaux ("De l'intervention chirurgicale dans les perforations intestinales de la fièvre typhoïde," *Soc. de chir.*, février, mai, 1908) reported at the recent discussion at the Société de Chirurgie, deal only with 100 French observations, but convey a better and more accurate idea of the prognosis; the 100 cases include 81 deaths and 19 recoveries (19 per cent), and of the recoveries, 11 were cases of localized peritonitis, of typhoid appendicitis, or of laparotomies performed for false perforations; therefore the percentage of recoveries in cases of intestinal perforation into the free peritoneal cavity during the course, or at the end, of an attack of enteric does not exceed 7 per cent. These figures have in other respects only a relative value.

[2] Loison, *Bull. de la Soc. de chir.*, 5 dec., 1900, p. 1077.

[3] *Soc. de chir.*, 12 dec., 1900.

yellow fluid was found in the peritoneum, and a perforation about the size of a lentil in the ileum about 16 inches from the cæcum. The opening was closed by means of a purse-string suture of fine silk, which was then infolded by five or six interrupted Lembert sutures. The peritoneal cavity was irrigated with normal salt solution, several pints being used at a temperature as high as the hands could bear, and drained with a large-sized tube and two strips of gauze. Two months later the patient had completely recovered.

Legueu's case was that of a child, 15 years of age, in the twentieth day of the enteric fever. Here again the onset was characterized by a violent pain, with rigidity of the abdominal wall ; the temperature, which had been 103°, fell to 100·4°, the pulse became thready and the face pinched. Operation was performed six hours after the onset. A certain quantity of purulent fluid was discovered in the abdomen, and 10 inches from the cæcum a punched-out hole, the size of a sixpence, was found on the free border of the ileum ; the intestinal wall in the vicinity of the perforation was " much thickened and very friable." All the sutures cut out, and in view of the impossibility of suturing the opening, Legueu adopted the plan of closing it with the omentum, which he spread over it and secured in position by suturing to the neighbouring intestinal wall. The abdomen was irrigated with boiled water and drained with a large tube. A fæcal fistula developed, which, however, closed spontaneously, and recovery was obtained in a month.

There can be no doubt that the prognosis of these operations depends to a large extent on two factors :. **the stage of the typhoid fever,** and **the interval between the perforation and the time of operation.**

Naturally, when the operations are performed at the height of an attack of typhoid fever, the results can hardly be expected to be brilliant ; for the most part the recoveries have been obtained in patients operated on during the stage of defervescence, after the third week, or even during convalescence, but with regard to this point there is nothing constant.

As to the need for **early operation,** its importance is so obvious that it is unnecessary to insist on it, but practically the time of operation is **subordinated to the diagnosis.** The earlier the perforation is recognized, the more rapidly will the operation follow, and the better will the patient's chances be.

It appears perfectly clear that in the majority of cases the onset of symptoms ought not to escape careful observation ; the reactions, though not striking, are none the less sufficiently demonstrative. *A sudden pain* at some point in the abdomen, in one of the iliac fossæ particularly,[1] is often mentioned : a pain which persists, is increased by pressure, and is followed by the characteristic *contracture of the abdominal wall ; the temperature undergoes a sudden alteration,* it rises or falls a degree and a half or two degrees ; *the pulse becomes very rapid,* small, and bad, the face pinched ; these points are quite sufficient without waiting for vomiting, which may

[1] An intestinal hæmorrhage, even if small, ought always to be noted as a premonitory sign of a possible perforation within the succeeding days.

be absent or delayed, hiccough, abdominal distention, etc.; it must not be forgotten that in these cases the indications are more urgent than in any other condition of peritonitis due to perforation.[1]

The operation is not as a general rule difficult, and ought of course to be carried out with all the rapidity possible.[2] The abdomen will be opened by a median incision below the umbilicus,[3] and **the cæcum looked for** immediately the pus has been evacuated; the perforation is usually situated in the terminal two feet of the ileum, sometimes in the cæcum itself, or again in the appendix.[4] Therefore examine the cæcum and appendix, then follow up the small intestine, cleansing it during the process, segment by segment. The perforation usually shows itself very quickly; often the position of the focus will be indicated by a collection of purulent lymph, or a track of fœtid and stercoraceous pus.

Draw the affected loop outside the abdomen and suture the perforation. We have already mentioned that the closure may be rendered very difficult by the friability of the intestinal wall; do not spend time in excising the margins of the orifice; it should simply be closed by a purse-string suture and then infolded by some interrupted Lembert sutures, picking up a good breadth of the adjoining wall, and be tied very slowly and gently. If the attempt at suturing should fail, it is essential to abstain from any prolonged intervention, such as a resection;[5] one must be content with occluding the perforation by omental or intestinal "grafting," or better, with **simply attaching the intestinal opening to the wound.** Cleansing and drainage of the peritoneum in the manner we shall immediately describe constitute the indispensable complement of the operation.

It may happen that two or three perforations may be found in the same intestinal segment,[6] and also that one of them may pass undetected. This possible *multiplicity of perforations* has been urged as an objection to

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[1] As Rochard has said (*Gazette des hôp.*, 23 juin, 1904, p. 705) the possibility of a "false typhoid perforation" is no reason for delay; it must not be forgotten indeed that in typhoid peritonitis of non-perforative origin, immediate operation is equally imperative; in 20 cases collected by Yates, 9 were not operated on and all ended in death. 11 were treated operatively and gave 4 recoveries. (*American Medicine*, May 2, 1903.)

[2] Local anæsthesia with cocaine is often indicated.

[3] The incision at the outer border of the rectus muscle provides a very direct approach to the ordinary situation of the lesions, the cæcum and the terminal part of the ileum; however, when there is any doubt, and when generalized peritonitis is present, median laparotomy possesses the greater advantages.

[4] We do not refer here to the cases of localized *paratyphoid appendicitis*, but to the acute perforations of the appendix occurring during the course of typhoid fever and situated in ulcerated appendicular follicles.

[5] Enterectomy is recorded nine times in the cases collected by Mauger, with only one recovery; it is evident that it ought to be reserved for cases with very large loss of tissue, or when multiple perforations are situated close together in a short segment of intestine, and where no other procedure is possible.

[6] Perforation of Meckel's diverticulum requires mention. Boinet and Delanglade (*Arch. gén. de méd.*, oct., 1899) and Heurtaux of Nantes have reported cases. Heurtaux's case, which is quoted in Mauger's thesis, is particularly interesting, as the patient was twice submitted to laparotomy and made a perfect recovery. The perforation, however, occurred during the stage of convalescence, the symptoms being sudden pain in the right iliac fossa, vomiting, and distention of the abdomen. Operation was performed by right iliac incision; the perforation was found almost immediately; it was situated in Meckel's diverticulum, which was about

operation ; it is fortunately much less common than was formerly believed ; Mauger, in the records of 107 operations, found that perforation was single in 95 and double in 12.

A more serious condition is the occurrence of *successive perforations*, which constitutes a fresh element of uncertainty with regard to the prognosis, and must be taken into consideration. A patient on whom Routier had operated, died on the tenth day, and at the post-mortem examination two fresh perforations were found ; a patient operated on by Brun died on the seventh day—five fresh perforations were present ; a little girl operated on by Morestin remained in excellent condition for nineteen days, and then succumbed suddenly,—at the autopsy the first lesion was found perfectly healed, but there was a fresh perforation which had been the cause of death.[1]

Notwithstanding these uncertainties and the bad prognosis, immediate operation provides the only possible chance of recovery ; and the increasing number of successful cases constitutes sufficient evidence of its legitimacy and the almost unhoped-for results which it may sometimes give.

Whether or not a gastric or intestinal perforation has been found and sutured, the last step of the operation must be the **cleansing and drainage** of the peritoneal cavity. The cleansing is in the majority of cases best done by means of *dry sponging*, with aseptic swabs and compresses ; the procedure must be conducted methodically, passing from the intestines to the abdominal parieties, to Douglas' pouch, to the iliac fossa, the hypochondria, etc. The object to be kept in view is the evacuation of all the extravasated fluids, without any rubbing of the peritoneal surface, and without any attempts to separate the new-formed adhesions. This is the best practice, at least when generalization of the infection has not been demonstrated.

When general purulent peritonitis is present, and particularly when the peritoneal cavity is flooded with intestinal contents, **irrigation of the peritoneum** finds its indications ; warm boiled salt solution will be used, and the irrigation continued till the fluid returns perfectly clear.[2] Free drainage must be provided by means of large tubes surrounded by aseptic gauze.

I need merely refer here to the benefits obtainable by the free administration of salt solution after these operations for peritonitis ; the results which it gives are in perfect agreement with the ideas expressed at the

2 inches long, the diameter of the index finger, and situated about 12 inches from the cæcum. Suture, irrigation, drainage. Five days later signs of intestinal occlusion appeared ; median sub-umbilical laparotomy was performed, and the obstruction was found to be due to superficial adhesions ; the adhesions were separated and the abdomen irrigated with warm saline solution. The patient, a boy 10 years of age, recovered. Of course, a perforated appendix or diverticulum ought to be resected.

[1] When signs of a second perforation occur, the reopening of the abdomen is always indicated. It has been done by Harvey Cushing. Operation is also necessary in the presence of symptoms of secondary intestinal occlusion, which has several times been observed.

[2] A glass reservoir, properly sterilized (see p. 21, or a simple glass funnel, fitted with a rubber tube, and a glass cannula—also boiled—are all the apparatus necessary.

beginning of this section with regard to the means of promoting recovery in these infections, and the important part played by the vital reaction of the organism in bringing it about. Artificial serum is a therapeutic agent of the utmost value in the struggle against infection, but it must be used in large doses[1] and persistently.

II.—PUERPERAL PERITONITIS.

Here again, the chances of recovery to a great extent depend on the degree of general septic intoxication; and the purulent peritonitis with a large effusion is the form in which the best operative results are obtained.

1. **Encysted Purulent Peritonitis.**—A huge intraperitoneal abscess may be present—an enormous purulent cavity, surrounded and enclosed in every direction by adhesions. Simple incision performed in time is sometimes followed by uneventful recovery.

Case 53.—A woman, 22 years of age, was taken ill, three days after her confinement, with a severe shiver and high fever, which ranged between 103° and 105°; at the end of some days the abdomen was found to be swollen, dull in almost the whole of its extent, and very tender; there was some diarrhœa, rapid enfeeblement, and an ecchymotic patch appeared in the trochanteric region, indicating the development of a metastatic lesion. Laparotomy was performed, about a gallon of pus evacuated, and the cavity was also found to contain very thick masses of purulent lymph; these were removed with the hands. The cavity was irrigated with two gallons of sublimate solution (1–1000). Two drainage tubes were placed at the angles of the wound, the one towards the epigastrium, the other into the pelvis. A large quantity of sero-sanguineous fluid escaped during the first few days: on the eighth day the discharge ceased. The temperature fell steadily to normal, and the patient made an uneventful recovery.[2]

Case 54.—A multipara, 32 years of age, was taken ill with shivers and very high fever (104°), and soon presented all the signs of peritonitis. Five pints of pus were evacuated by aspiration, and marked improvement resulted; but the pulse again became rapid and feeble, and œdema of the abdominal wall appeared; a median sub-umbilical incision was therefore made. The cavity was emptied, irrigated with warm boric and salicylic lotion, and drained. Recovery ensued.[3]

It would be easy to give many cases of this kind, characterized by the sudden and acute onset of symptoms (usually five or six days after confinement or a miscarriage), high fever and diarrhœa, but without those signs of serious septic absorption which we shall mention immediately in connection with the other varieties. The issue of the affection is not decided in a few days or in twenty-four to thirty-six hours, as is sometimes the case

[1] At least when the renal function is active.

[2] Raymond, of Limoges, *Assoc. franç. pour l'avanc. des sciences*, Limoges, 1890, and *Revue de chir.*, 1890, p. 920.

[3] Bufalini, *Raccoglitore med.*, 1897, No. 3.

in very acute puerperal septicæmia ; it runs a prolonged course without any notable aggravation from day to day. The abdomen enlarges slowly, and becomes doughy, resistant, and dull over a large area ; the abdominal wall sometimes becomes œdematous, particularly in the peri-umbilical region. In short, a diffuse peritoneal abscess slowly develops.

As Noble, of Philadelphia, has pointed out,[1] frequently in these cases there is pre-existing disease of the uterine appendages, which, owing to post-partum infection, become the starting points of acute but circumscribed suppuration.

This localized purulent peritonitis is always serious, but still is often curable by a comparatively simple operation : **sub-umbilical median incision, evacuation, and drainage.**

Certain points in the treatment, however, require consideration. First, irrigation[2] is of doubtful utility, and is associated with a certain amount of danger ; as a rule it is better to limit treatment to *mechanical cleansing* of the suppurating cavity and its offshoots with gauze swabs and compresses.

The drainage requires careful attention, to guard against possible stagnation of pus in the dependent pockets. When the abscess cavity extends to the bottom of Douglas' pouch, it is an excellent practice to provide a dependent channel by draining through the vagina.[3]

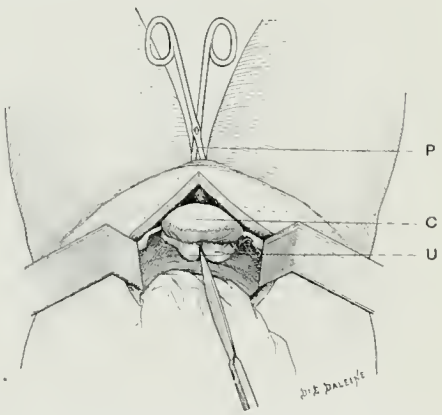

Fig. 434.—Abdomino-vaginal drainage. (P) Long, curved forceps pushing up the posterior fornix. (U) Uterus. (C) Incision into the posterior fornix between the jaws of the forceps.

To obtain this abdomino-vaginal drainage, the vagina having been douched and carefully cleansed—a precaution which it is always advisable to take in advance in operations of this kind—a pair of long forceps, a curved clamp for instance, will be introduced into the vagina and the blades carried upwards behind the cervix, so as to push up the posterior fornix strongly (*Fig.* 434), and the incision will be made from the abdomen into the vagina between the separated points of the blades, which will then be passed through the opening into the abdomen to seize the drainage tube and draw it down into the vagina. The intravaginal portion of the tube will be packed round with gauze.

Lastly, if after the abscess has been emptied a ruptured tube or a tube full of pus should be discovered, its removal will be advisable. But caution is needed against going too far with these complementary procedures.

[1] P. Noble, *Amer. Gynecol. & Obstet. Jour.*, April, 1895.

[2] With boiled salt solution at 104° F.

[3] Simple colpotomy with drainage has been practised with success on several occasions.

which take up time and complicate an operation, the principal merit of which ought to be its brevity ; good drainage constitutes the fundamental object of the operation.

2. **Diffuse Purulent Peritonitis.**—Alongside of these cases of encysted purulent peritonitis we must place the much graver condition of **diffuse purulent peritonitis**, with its more rapid course, and which, in a very short time, causes such a breakdown in the resisting powers that operation usually comes too late.

Still, encouraging cases are not altogether uncommon. Bouilly's first cases, reported in 1889,[1] are well known : a young woman was taken ill with shivers on the third day after her confinement ; on the eleventh day the temperature was 105°, palpation of the abdomen was impossible because of its extreme tenderness, dyspnœa was very great, due as much to infection as to mechanical interference with the diaphragm. The abdomen was opened by an incision about 2 inches in length, sufficient to allow the cannula to be introduced and directed with the hand towards the various parts of the peritoneal cavity, which was irrigated with boiled water to which a little sublimate solution had been added ; the temperature fell at once, all the symptoms subsided, and the patient recovered in thirteen days.

Another successful case was that of a woman confined on the 10th June, 1887, who presented symptoms of infection on the 12th, and on the 25th was so ill that Bouilly hesitated to interfere. However, operation was performed as before—the same short incision, the same irrigation—and again the patient recovered.

In a third case,[2] a patient 22 years of age developed diffuse purulent peritonitis, with feeble pulse, high fever, laboured and shallow respiration. Laparotomy ; 2 pints of pus were evacuated, the greenish fibrinous adhesions were separated, and several encysted collections of pus found in the pelvis and opened Free irrigation with salt solution ; Douglas' pouch was packed with strips of iodoform gauze, the ends of which were brought out at the lower part of the abdominal incision. Immediate improvement followed : the pulse and temperature fell, the vomiting and diarrhœa ceased. From time to time a rise of temperature occurred, due to retention of pus ; finally the patient recovered, though a fistulous track persisted.

These cases are all somewhat similar, and in those which have terminated in recovery there are always the fibrinous adhesions, the tendency to encystment in spite of the great extent of the peritoneal suppuration, and the multiple foci, more or less localized ; in a word, if there is not a single large peritoneal abscess, there are usually multiple abscesses, rather than pus diffused freely amongst the intestinal coils.

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[1] *Congrès franç. de chir.*, 1889.

[2] F. v. Winckel, "Ueber die Köliotomie bei der diffusen eitrigen puerperalen Peritonitis." *Therapeutische Monatshefte*, April, 1895.

The principles which govern the operation are based on these characters. Above all, it should be rapid and simple. A long incision which opens the way for evisceration of the distended intestines is useless, and may be dangerous by prolonging the operation and increasing the difficulty of replacing the intestines; therefore make a suprapubic incision about three inches in length, and open the peritoneum very carefully, through a fold raised with the dissecting forceps. Do not forget that the distended intestine is applied very closely to the deep surface of the wall, and may very easily be wounded.

Then let the fluid escape; introduce the finger into the cavity and take note of its characters; explore the pelvis and the bottom of Douglas' pouch, where any secondary abscesses are usually situated; then commence the irrigation with warm boiled saline solution, and complete the cleansing by drying out the iliac fossæ, the pelvis, the lumbar regions, etc., with gauze compresses.[1] Make no attempts to detach the flakes of fibrinous lymph which cover the loops of intestine in the neighbourhood of the accumulations of pus; this would be a troublesome and useless undertaking; further, in separating them, the intestinal wall to which they are adherent would very soon be injured; be content with drying them as well as possible by gentle pressure with a compress.

Therefore, **a short incision, irrigation, and drainage** (pelvic, iliac, and abdominal drainage) are the principal features in the surgical treatment of these cases;[2] nature will do the rest, if there is still time.

Lastly, here again we may meet with the *hyperacute septic form of peritonitis*, in which the local lesions occupy only a very secondary position, and the symptoms of intense toxæmia constitute the outstanding features; in these cases, so rapid is the march of infection that indications for operation very rarely arise.

III.—PNEUMOCOCCAL PERITONITIS.

This condition occurs most frequently in children,[3] and is the most curable of all the varieties of peritonitis when it presents itself in its typical *encysted form*

[1] To facilitate cleansing and irrigation, it will often be useful to incline the patient successively to one side or the other, and alternately to raise and lower the pelvis. These alterations in position ought not, however, to go so far as the complete inversion employed by Evans in a case of puerperal pelvi-peritonitis, where the patient seemed to be "at death's door." Laparotomy was performed, and about two pints of fluid escaped; warm water was then injected into the peritoneal cavity, and the patient was turned on to her face; the manœuvre was repeated three times before the water was returned clear. A large drainage tube was placed in the peritoneal cavity. At the end of some days the tube became blocked, and it was necessary to open the wound and repeat the irrigation. The patient recovered. (*Medical Record*, April 12, 1890, p. 407.)

[2] It is advisable to bear in mind the usefulness of enterostomy in certain cases of peritonitis, whatever their origin may be, in which the symptoms of intestinal paralysis and pseudo-obstruction are predominant: the object of the enterostomy being to relieve the toxæmia and, possibly by emptying the intestine, to restore its contractility. (Doyen; Heidenhain.)

[3] The number of cases observed in adults (persons over 16 years) is, however, comparatively high; in a series of 106 cases collected by J. Jensen and verified by bacteriological examination, 48 occurred in adults and 58 in children. (J. Jensen, "Ueber Pneumokokkenperitonitis" *Arch. f. klin. Chir.*, 1903, Bd. lxix., p. 1134, and Bd. lxx., p. 91.)

Case 55.—A boy, 17 years of age, very pale and much emaciated, was sent to me by my colleague, Dr. Ménétrier with the diagnosis of pneumococcal peritonitis; a very prominent swelling occupied the whole breadth of the lower part of the abdomen. The swelling was dull and tense, and gave an undoubted fluid wave on transverse percussion. The symptoms were of six weeks' duration; the onset had been sudden, and characterized by fever, distention, very acute pains in the abdomen, and vomiting; at the end of a few days there was some remission in the symptoms, but the abdomen remained full and painful, it became progressively larger and more tense, while the fever persisted, and the general condition steadily grew worse. I performed median sub-umbilical laparotomy, and immediately opened into a huge abscess cavity, filled with thick pus and lined with fibrinous lymph. The pus was evacuated, the cavity carefully cleansed with gauze compresses, and two drainage tubes were placed in its lower part. A bacteriological examination showed that the pus contained the pneumococcus alone. The patient recovered, and still remains well.

In the majority of the published cases the evolution has been the same: a sudden onset, with sharp abdominal pain situated around the umbilicus, or sometimes in the right iliac fossa, but without the definite localization of an appendicular pain; it is accompanied by bilious vomiting and diarrhœa (this last symptom is often persistent and occurs with sufficient constancy to be of great diagnostic value), fever, sometimes as high as 103° or 104°. But the initial outburst subsides, the symptoms of general septic absorption remain moderate, the illness drags on a slow course, and usually it has been after two or three weeks that operation has been performed.[1] It has been said, with truth, that the single fact of the long duration is the best indication of a benign, non-generalized form of infection. Usually this suppurative pneumococcal peritonitis localizes itself to **the umbilical zone**; thence it may extend into the right flank and almost to the under surface of the liver; the great suppurating cavity lies immediately *below the abdominal parieties*, and it displaces the intestines upwards or laterally *en masse*. It manifests itself, therefore, on examination, by more or less definite distention of the inferior and right lateral portion of the abdomen, and by complete dullness, which first occupies the sub-umbilical region, but often in the end extends upwards, the median part of the advancing border reaching to or passing beyond the umbilicus, while the lateral horns are lost in the iliac fossæ; within the dull area deep-seated fluctuation is more or less evident.

Another important sign, to which Brun[2] has drawn attention, is the **unfolding and bulging of the umbilicus**, and frequently an extensive *area of redness* in the peri-umbilical region. We know besides that spontaneous rupture of the abscess at the umbilicus has several times been observed. In pneumococcal peritonitis immediate operation is not so urgently called for as in other forms; but it is still imperative, and we may

[1] In a case of M. Malapert's, reported by M. Richelot to the "Societe de Chirurgie," the symptoms were of 29 days' duration; five pints of pus were evacuated by operation; the patient, a little girl nine and a half years of age, recovered. (*Bull. de la Société de Chirurgie*, 17 mars, 1897, p. 220).

[2] Brun, "Péritonite à pneumocoques chez l'enfant." (*Presse médicale*, 27 février, 1897, No. 17).

add that, owing to the comparatively mild course of the affection and the uncertainty which usually exists in the early stages, the indications for operation are usually incontestable when the surgeon is called in.

But pneumococcal peritonitis may also be *diffuse*: in a patient on whom Walther[1] operated, there was "an extensive effusion, absolutely free in the abdominal cavity, the intestinal coils floating in the pus without a trace of adhesions." The patient had been under the care of M. Hanot, suffering with pneumonia, and had suddenly developed grave abdominal symptoms, characterized principally by obstruction. The pus was mixed with masses of fibrinous lymph, and the pneumococcus was the only organism present. This diffuse variety is more common in the adult, although it has been observed in children, and its prognosis is always grave; in 58 cases occurring in children, there were 33 of encysted peritonitis, with 31 recoveries; 25 of diffuse peritonitis, with 21 deaths.[2] Surgical treatment is therefore very necessary and most urgent, excluding, however those cases of general pneumonic infection, with multiple foci, pleuro-pulmonary, pericardial, meningeal, etc., where the intraperitoneal suppuration forms only a secondary part of the generalized process.

In the ordinary type, where there is *a single large purulent cavity*, the operation is extremely simple. It is an incision of an abscess, nothing more; and it ought to be nothing more, as the principal care of the surgeon must be the preservation of the localized character of the lesion and the avoidance of any interference with the lining of fibrinous lymph which protects the general cavity.

Therefore make a **median subumbilical incision within the dull area;** divide the skin and the linea alba; open the thickened peritoneum about the middle of the incision, at a place which is definitely tense and fluctuating,—not too near to the pubis, above which the bladder may be fixed by adhesions; not too close to the umbilicus, where one might possibly go outside the limiting adhesions. Practically, however, the cavity is opened with the greatest ease. As soon as the pus appears, introduce a finger into the opening, and on it extend the incision upwards and downwards, as may be necessary.

Allow the pus to escape. It is usually greenish-yellow in colour, fairly thick, odourless, and *mixed with grumous masses of fibrinous lymph* which are, in a certain degree, characteristic. The cavity is of very variable size, but is always large; it extends into the iliac fossæ, into the pelvis, to the bottom of Douglas' pouch, and often contains a quart or more of fluid.

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[1] Walther, *Bull. de la Société de Chirurgie*, 19 mai, 1897, p. 382. Jalaguier (*Ibid.*, 28 avril, 1897, p. 323), in four laparotomies for pneumococcal peritonitis had three recoveries and one death: in the fatal case the abdomen was full of pus, and at the autopsy, a focus, which had escaped detection at the operation, was found behind the spleen and another behind the liver.

[2] J. Jensen, *loc. cit.* In 33 cases of encysted peritonitis, 1 recovered without operation 32 were treated by operation, with 30 recoveries (the 2 deaths occurred late and were due to secondary complications); of the 25 diffuse cases, 12 were operated on, and 4 recovered. In 48 cases of pneumococcal peritonitis occurring in adults, there were altogether 38 deaths and 10 recoveries; 14 of the patients were operated on, and amongst them 9 recovered.

When the evacuation is complete, dry out the cavity carefully with sterile swabs or compresses,[1] drain it with one or two large tubes placed right to the bottom of the most dependent part, and suture the upper part of the incision.

This completes the operation; the condition is a sort of abdominal empyema, which is treated in the same manner as the analogous one occurring in the pleura, but as a rule closes up very much more quickly; it must not be forgotten, however, that relapses may occur and that ill-drained recesses of the main cavity may become the starting-points of fresh foci, and also that other distant pneumococcal suppurations have been observed during the stage of convalescence.[2]

In the diffuse form the treatment is identical with that of any other diffuse purulent peritonitis.

ABDOMINAL ABSCESS.

Under this heading we shall study: (1) The abscesses of the *anterior abdominal wall*; (2) The abscesses in the *right hypochondrium*, hepatic abscess, subphrenic abscess; (3) The *perinephritic* abscesses; (4) The *hypogastric* abscesses; (5) The abscesses in the *iliac fossæ*.

I.—ABSCESSES OF THE ANTERIOR ABDOMINAL WALL.

I need merely mention the *subcutaneous abscesses*, the *superficial umbilical abscess*, forming a rounded, red, and fluctuating swelling—*the abscesses of the lateral walls*, spread out often over a large area, and which remain indurated and flat for a long time before softening and forming a fluid accumulation—and also *the abscesses in the sheath of the rectus muscle*, which are rarely seen and which harden and become fixed when the patient is made to sit up. Early incision is the only treatment, and presents no difficulties.

It is a very different matter with the **deep-seated suppurations, pre-peritoneal**, which are often associated with very disconcerting symptoms, and which one must learn to recognize early and to open properly. For instance:—

Case 56.—A man, some 60 years of age, very stout, and suffering from diabetes, was brought to me at the Beaujon hospital in the following condition: he had been ill for a fortnight with fever, shivers, some vomiting and intense abdominal pains, which had begun somewhat suddenly; the abdominal wall in the whole of its lower part from the umbilicus to the pubes presented a reddish swelling which extended out to the flanks; the swelling was doughy,

[1] Do not neglect to explore, without rupturing anything, the walls of the cavity, and remember the diverticula and possible secondary cavities in the immediate vicinity.

[2] In one of Brun's patients, a month after the laparotomy it was necessary to incise the pleura and empty a pneumococcal empyema (*loc. cit.*)

almost hard, on palpation ; it was like a thick, flat sheet forming part of the abdominal wall which could be taken between the widely separated hands and moved about like a tumour. I made a median sub-umbilical incision, dividing the skin and the linea alba, and below the latter, that is, behind the musculo-aponeurotic wall of the abdomen, I opened into a large abscess which contained more than 3 pints of pus. There was, immediately in front of the peritoneum, a cavity 4 inches in depth and more than 6 inches in diameter. This case is the type of Heurtaux's sub-umbilical abscess.

One must not wait until fluctuation becomes evident and superficial in these diffuse subparietal abscesses, which often, even in the acute forms, present and retain the hardness of a sarcoma for a considerable time. Early operation is of the greatest importance. A median incision will be made, and deepened layer by layer, and one must remember that the pus *lies behind* the linea alba.[1]

II.—ABSCESSES IN THE HYPOCHONDRIAC REGIONS—SUBPHRENIC ABSCESSES—HEPATIC ABSCESSES.

The right hypochondrium and all that "intrathoracic" zone of the abdomen bounded above by the diaphragm may become the seat of deep suppurations, the diagnosis of which is often difficult, and which require somewhat specialized measures for their surgical treatment. This group includes the abscesses and suppurating hydatid cysts of the liver, and the subphrenic abscesses.

I cannot enter into a detailed discussion of these hepatic and peri-hepatic accumulations, still less go into the large question of true abscess of the liver. I must, however, point out that early drainage is here, as in any other abscess, superficial or visceral, the necessary treatment, and add that under certain circumstances—the size of these purulent accumulations, their situation, and the disturbances, local and general, to which they give rise—demand immediate operative intervention.

There are two possible conditions from an operative point of view: (1) *The abscess shows itself on the surface* by a swelling in an intercostal space, below the costal border, or in the epigastrium ; (2) *The abscess remains hidden* in the depths of the hypochondrium.

1. **The Abscess shows itself on the Surface.**—It renders itself evident by a more or less prominent swelling, or at least, on palpation (*Fig.* 435), as a fluctuating tender mass which leaves no doubt as to its nature, though there may be some with regard to its exact topography.

[1] Some kinds of foreign bodies are found not uncommonly in these abscesses : umbilical concretions, formed of sebaceous material and epithelial débris, or sebaceous cysts. In a case operated on by Demoulin, "a body the size of a cherry stone, and presenting the appearance of a sebaceous cyst, was found in the cavity. The body was indeed composed of sebum, but it possessed no enveloping membrane. The condition was therefore an abscess consecutive to the penetration of an umbilical concretion into the deep cellular tissue of the region or to inflammation around a sebaceous cyst, the contents of which were represented by the foreign body found in the cavity." (Duplay, "Sur un cas d'abcès profond de la région ombilicale." *Bulletin médical*, 3 jan., 1897. No. 1.)

In some cases the skin may even be reddened and œdematous, and below it quite superficial fluctuation may be detected; the abscess is approaching the surface by a narrow channel through the wall, and the necessary operation presents no difficulty; free incision of the subcutaneous extension, enlargement of the channel of communication, and drainage of the deep abscess. Whatever may be the situation of the initial focus, no other procedure is of any value.

Simple incision is also applicable to the **subphrenic abscesses** which present in the epigastrium or below the costal border (*Fig.* 436); a vertical incision, median or lateral, if fairly long, will suffice for the evacuation and

Fig. 435.—Examination of the right infracostal region; palpating for a hepatic or subhepatic abscess.

drainage of the cavity; in the cases of very large abscesses, the primary incision may sometimes have to be amplified by an extension along the margin of the thorax. Some other abscesses may develop in the posterior part of the subphrenic zone and spread into the lumbar region; they are sometimes retro-peritoneal, and included in the space between the posterior border of the liver and its attachments to the diaphragm; although they may originate from various sources, they most frequently follow appendicitis. They present signs very like those of a high situated perinephritic abscess; the maximum pain is felt posteriorly, below the last ribs, external to the erector spinæ, and on bimanual palpation a deep-seated swelling is detected at the same level.

The abscesses belonging to this group must be opened posteriorly; the incision follows the outer border of the erector spinæ and extends upwards for a variable distance over the lower ribs.

Lastly, mention must be made of the **gas-containing subphrenic abscesses**, of which the following are examples :—

Case 57.—A man, 40 years of age, had been admitted under the care of my colleague, M. Courtois-Suffit, with very grave abdominal symptoms, violent pains vomiting, distention, etc. The pain was definitely localized to the right hypochondrium ; in this region, and extending into the epigastrium, was a large rounded swelling which contrasted with the state of the sub-umbilical zone and gave a bilobular appearance to the abdomen ; over the whole of the swelling there was resonance which entirely masked the liver dullness. I made a median supra-umbilical incision about 10 inches long. The extraperitoneal cellular tissue was thickened and infiltrated ; as soon as I had penetrated it, and a small

Fig. 436.—Examination of the right infracostal region ; the lower limit of a subhepatic swelling.

opening was made in the peritoneum, a great quantity of extremely bad-smelling gas escaped noisily, mixed with pus. At least 2 pints of this greyish, stinking pus escaped, accompanied by large bubbles of gas ; the cavity was of enormous size, and closed in all directions ; its upper wall was formed by the diaphragm, the lower by the liver and stomach, displaced downwards, while posteriorly it extended between the liver and diaphragm as far as the finger could reach. It was irrigated with boiled water, and two large drainage tubes were placed in it. Complete and lasting recovery ensued.[1]

Case 58.—The second case was that of a woman, 41 years of age, emaciated and cachectic, who had suffered for a long time with gastric trouble, and was suddenly seized with intense pains in the upper part of the abdomen, with distention, vomiting, and fever. Two days later there was a large epigastric swelling, resonant in its whole extent, and entirely masking the hepatic dullness at the same level, the " bruit d'airain " (coin sound), and all the signs of pyo-pneumothorax were detected. By a median epigastric incision I penetrated into an enormous cavity, filled with gas and pus, which extended far under the

[1] " Abcès gazeux sous-phréniques." *Bull. de la Soc. de chir.*, 1897, p. 643.

diaphragm, particularly towards the left. Drainage. For the first few days all liquids ingested escaped by the wound, then the condition gradually improved, but a persistent fistula rendered a secondary operation necessary. Ultimately complete recovery was obtained.[1]

Fig. 437.—Gaseous subphrenic abscess; rounded epigastric prominence.

These gaseous subphrenic abscesses are most often due to gastric or duodenal perforations, and the usual abrupt onset of the initial symptoms is characteristic. More or less quickly a swelling shows itself in the epigastric region;[2] it is often of considerable size, and forms a prominent rounded boss on the abdominal wall (*Fig.* 437). The swelling is entirely tympanitic when the patient is lying down; when he is made to sit up a dull zone of variable extent appears at its lower part (*Fig.* 438), while in the upper part the tympanicity persists.[3]

In such a case the incision must be made within the prominent area in the middle line or at the outer border of the rectus; as soon as an opening is made in the peritoneum, bad-smelling gas and pus escape noisily; it only then remains to enlarge the incision sufficiently, care being exercised to avoid going too low, and beyond the adventitious and often feeble barrier which limits the cavity. With regard to the perforation,[4] it is as a rule inadvisable to look for it under the circumstances; the essential indication to be met is to open the abscess freely, cleanse the walls, place drainage tubes to the bottom of the cavity and any secondary branches of it, and to leave the wound widely open.

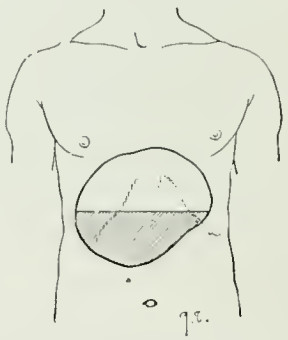

Fig. 438.—Gaseous subphrenic abscess; resonant zone above, dull zone below; *patient in sitting position.*

In the case of an **intra-hepatic abscess or suppurating hydatid cyst,** the conditions are different. If the inflammatory area is adherent to the abdominal wall, a simple incision within the adherent zone is of course indicated; but there is no sure method of determining the existence of adequate adhesions, still less of recognizing their extent. To incise forthwith down to the pus is attended with very great risk of infecting the

[1] "Les suppurations de la zone sous-phrénique." *Semaine médicale*, 26 mars, 1902.

[2] Of course these gaseous abscesses do not always point in the epigastric region; they may be buried in one or the other hypochondrium, and only accessible by the transpeural route (see later).

[3] Within the resonant area, the cracked-pot sound, the coin sound (*bruit d'airain*) and metallic tinkling may also be obtained, and if the patient is gently shaken, succussion, the characteristic sound produced by a mixture of fluid and air in motion, is produced.

[4] Quite often it is small, and closes spontaneously after a variable time. At other times

peritoneum, no matter how tense and projecting the wall of the abscess may be. It is true that the pus escapes outwards in a jet as soon as an opening is made; but accordingly as the pocket empties, it retracts and ascends, sometimes very high, and inevitably pours the last of its contents into the peritoneal cavity. These contents may be sterile in some liver abscesses, but it is now well established that **the sterility of hepatic pus is by no means constant**, and it is impossible to place any reliance on the chance.

It will be wise, therefore, to reserve the Stromeyer-Little practice of an incision going right down to the pus, for the cases where an abscess is pointing under red and œdematous skin, and apparently is about to burst spontaneously. Excluding these cases—which are of course exceptional—the safer and better plan is as follows:—

Incise the abdominal wall, layer by layer, over the swelling which you feel or see, down to the peritoneum; incise it in its turn; **if it is adherent over a sufficient area**, go on without hesitation, but not without having first, by means of the finger, made sure that adhesions are continuous all round and form an adequate barrier against the entrance of pus into the peritoneal cavity. Then incise the fluctuating swelling like an ordinary abscess; often it will be needful to traverse a layer of hepatic tissue, which is, however, as a rule not very thick in the case of superficial, prominent, and adherent abscesses such as we are now considering. Open it freely with the knife; and if there is any profuse oozing from the edges of the incision, touch them with the thermocautery at a dull-red heat. Conditions occasionally arise in which this operation is required as an urgent measure, not only in large hepatic abscesses complicated with threatening septic symptoms, but also in cases of suppurating hydatid cysts. I cannot give a better illustration than the following case:—

Case 59.—An unfortunate man, 54 years of age, was sent to me in a lamentable condition: emaciated, jaundiced, exhausted by profuse perspirations and widely oscillating daily fever. He had suffered for a month with extremely severe and constant pain, which had begun suddenly in the right hypochondrium and thence radiated all over the abdomen. The right portion of the epigastric region was occupied by a rounded swelling, very painful and manifestly fluctuating, which pushed up the lower margin of the thorax. A longitudinal incision was made along the outer border of the rectus muscle, following the chief axis of the swelling; the peritoneum was adherent to the underlying mass, and could neither be picked up in a fold nor separated; a puncture was made with the scalpel, and then an incision from above downwards, the whole length of the parietal wound; a great quantity of pus mixed with hydatid vesicles escaped; the cavity was irrigated with boiled water, and two drainage tubes were introduced. The whole operation had only lasted ten minutes. The acute symptoms immediately subsided; ten days later the jaundice had disappeared, and complete and lasting recovery finally resulted.

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it is large and irregular, and a fistula may persist for which some subsequent operation may be required. Lastly, let us mention two very serious possibilities: very extensive and irremediable destruction of the gastric wall; multiple perforations giving rise to multiple abscesses, usually most difficult to expose and empty.

There can be no doubt that an earlier incision would have spared this patient a great deal of pain, and prevented the general impairment of health which had assumed such threatening characters at the time of the operation.

The technique is not so simple in the second hypothesis: the incision has been made as before over the prominence, and the peritoneum opened with the usual strict precautions, but **the swelling is found non-adherent, free in the general cavity.** What is to be done?

Protect the general peritoneal cavity before liberating the pus: that is an invariable law of abdominal surgery. But how is it to be accomplished?

If the swelling is not too prominent, too tense, nor its wall too thin, it may be sutured to the abdominal wall by a circle of U-sutures circumscribing the area to be incised. Always begin at the lower border and work upwards; use a full curved needle, pick up a fairly broad bridge of the wall of the abscess or cyst, and tie the ends of the sutures in front of the superficial abdominal aponeurosis, without pulling them too tightly; exact apposition must be obtained, but nothing more, and the friable hepatic tissue will cut under any forcible constriction. Devote ample time to properly placing these sutures, so as to provide an adequate protective barrier; the time spent will be more than balanced by the additional security obtained.

But when there is a large, tense, spheroidal mass which bulges into the wound, with its thin wall obviously ready to burst; or again, when unfortunately one of the sutures has perforated the wall and the fluid begins to escape, then relinquish the attempts at suturing, and slip a large compress under the lower end of the swelling at the lower angle of the wound, insert others at the sides and above, to completely envelop it on all sides; now open the cavity freely and allow the stream of fluid to escape. Remember that these tense accumulations empty themselves very quickly and the walls retract; therefore, immediately the first jet has escaped, seize the edges of the incision with forceps, and unite them to the abdominal wall by a series of sutures, the protecting compresses being withdrawn one by one as the sutures are passed.

Case 60.—A girl, 18 years of age, born in Algeria, where she had lived for 12 years and had been treated for indefinite malarial symptoms, was admitted into my hospital service in April, 1900, with all the symptoms of abscess of the liver. The onset had occurred eight days previously; it had been characterized by a sudden pain in the right hypochondrium, shivers, and fever. On admission the temperature was 104°, the pulse rapid, the face cadaverous, the pain extremely acute in the hepatic region, and from there radiating to the iliac fossa and over the entire abdomen. The lower border of the liver extended a hand-breadth below the ribs; it formed a prominence which pushed up the abdominal wall, and on palpation, a rounded swelling, extremely tender and doubtfully fluctuating, could be felt very definitely on the anterior surface of the organ and extending to the lower border. A diagnosis of *intrahepatic suppuration* requiring immediate operation, was made.

I opened the abdomen by a vertical incision along the outer border of the rectus; the surface of the liver was distended by a reddened, ovoid, non-adherent swelling. After having explored the iliac fossa and made sure that the appendix was healthy, I spread out below the liver two large aseptic

compresses, which completely shut off the general peritoneal cavity, and proceeded to incise the swelling. I opened a large abscess, which contained at least two pints of thick, reddish pus; the cavity appeared to be single, without any diverticula. Once the intra-hepatic cavity had been emptied and cleansed, I attached the liver to the wall by a series of catgut sutures, placed all around the opening, and left two drainage tubes in the cavity. The patient was discharged at the end of five weeks, quite well, no sinus having remained.

When proper care is exercised, this free incision at the centre of an area surrounded by an adequate barrier of protecting compresses; followed by secondary fixation to the abdominal wall, is a rapid procedure which gives excellent results.

However, it is not so safe as the following method: the swelling is exposed and surrounded with gauze compresses, it is then *punctured* and emptied as far as possible with an aspirating trocar; as soon as it is sufficiently relaxed, it is fixed to the abdominal wall by a circle of sutures, and then the cavity is opened freely on the trocar.

This **preliminary puncture** becomes necessary when instead of a swelling situated close to the surface of the liver there is found—or at any rate supposed to exist—a central cyst or deep abscess, which produces an extensive enlargement of the liver, but without any external sign to indicate its exact position. Make the puncture with an aspirating trocar; do not be afraid of going fairly deep, to a depth say of 2 inches, and if necessary repeat the puncture in other directions. If pus comes, let it run away and empty the pocket as far as possible; then, leaving the trocar in place, proceed to suture the liver to the wall by a sufficient number of U-sutures. After that has been done satisfactorily, incise the hepatic tissue freely, down to the focus, with the knife if the thickness of tissue to be traversed is not great, with the thermocautery if the abscess lies deep. A few sutures connecting the lips of the hepatic incision to the skin complete the operation.

By these various manœuvres the intrahepatic accumulation is rendered extraperitoneal, and can then be treated like any other abscess: careful cleansing with gauze swabs in holders, drainage with two large drainage tubes without any gauze mesh, and a moist dressing. It is often advisable during the after-treatment to place the patient in the sitting position in bed.

2. **Deep-seated Abscesses, "Intra-thoracic."** — Here there is no apparent prominence, no swelling appreciable on epigastric or subcostal palpation; the base of the thorax is distended as a whole, the lower intercostal spaces are enlarged and bulging, the dullness extends up to the angle of the scapula and terminates above in a dome-like convexity; the respiratory sounds, which are completely lost over the lower part of the chest, reappear suddenly with their normal characters at the confines of the dull zone. The liver is scarcely depressed below the costal margin; the inflammatory focus lies at the bottom of the hypochondrium; **there is therefore, in the subdiaphragmatic region, a hepatic or perihepatic accumulation of pus to which a way must be opened.**

And the symptoms are sometimes so urgent at the time when the patient is seen, that operation is required without delay. Thus it was in the case of a woman some thirty years of age, who was sent to us suffering from severe dyspnœa, with high fever, a rapid and feeble pulse, and a pale, drawn, anxious face; the base of the thorax on the right side was considerably enlarged and occupied on its postero-lateral aspect by a large rounded prominence; the liver was very little depressed, but the dullness extended to the scapula, and it was quite evident that there was an enormous collection of fluid within that portion of the thorax.

I made a postero-lateral incision, 6 inches in length, along the 9th rib. I excised a segment, 4 inches long, of that rib; below it I incised the thoracic wall and united the upper lip of the incision to the diaphragm by a series of U-sutures. I then incised the diaphragm, and opened at once into a huge suppurating cystic cavity.

The transpleural route[1] is the only one applicable to these high-placed "intrathoracic" abscesses, and the operation is performed in the following manner: As a rule one rib, sometimes two, must be resected; a simple incision in an intercostal space does not give sufficient room, and may be associated with considerable danger by interfering with the steps necessary for adequately protecting the pleural cavity; it is indeed only applicable to cases in which an abscess is pointing in an intercostal space, and which therefore enter into the category already studied.

Therefore resect the 8th, 9th, or 10th rib, usually the 9th, for a length of 4 or 5 inches at least, measured from the angle. With the patient lying on the left side, properly supported, make a long postero-lateral incision over the rib selected; go right down to the bone at once; separate the periosteum with the elevator; divide the rib posteriorly close to the angle, and, raising up the anterior segment, complete the periosteal separation in front, and by a second cut with the bone forceps excise it. Incise the thoracic wall carefully in the bed of the rib by small repeated cuts. Then any of the following conditions may present themselves:—

(*a*). *One penetrates into a thickened, infiltrated, yellowish mass of tissue in which all the layers are fused indistinguishably together*: a simple continuation of the incision will then speedily conduct the operator into the purulent focus.

(*b*). Once the wall, that is to say, the costal periosteum and the parietal pleura, is incised, *one opens into the pleura*, not into a gaping cavity, but a serous space, a species of narrow slit, which, however, can be distinguished without difficulty; but this space is not in free communication with the general pleural cavity; it is free to only a limited extent, *being closed by adhesions*, and the two layers of the pleura, fused together in the diaphragmatic area, form a partition above the parietal opening. Make

[1] This transpleural operation is the one most often required in dealing with subphrenic accumulations. Of 60 cases occurring in Körte's practice and reported by M. Grüneisen, the abscess was opened through the pleura after costal resection in 41. These 60 cases have in all given 40 recoveries and 20 deaths. (M. Grüneisen, "Ueber die subphrenischen Abscesse, mit Bericht über 60 operirte Fälle." *Arch. f. klin. Chir.*, 1903, Bd. 70, 1, p. 1).

sure by digital examination that the partition is uninterrupted and sufficiently firm to protect the general pleural cavity, and then, as before, continue the operation by incising the diaphragm. But even when the adhesions seem trustworthy it is always a wise precaution to support them by suturing the upper lip of the diaphragmatic incision to the parietal wound.

(*c*). There is another possibility: one may open into the **free pleural cavity**; this is an eventuality which must always be kept in mind.

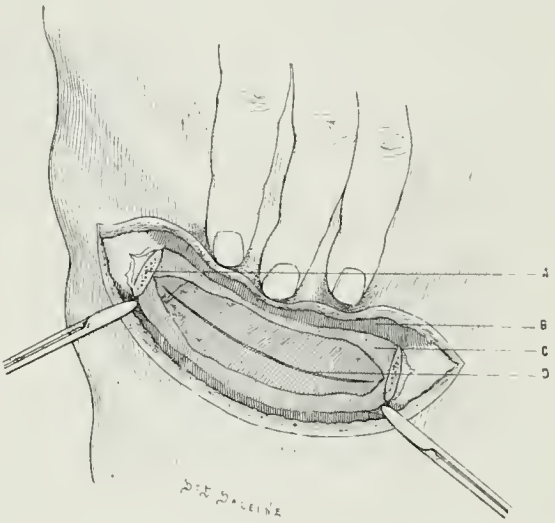


Fig. 439.—Transpleural incision of a subphrenic abscess; *temporary closure of the pleural cavity*: diaphragmatic incision. (A) Resected rib. (B) Intercostal wall. (C) Parietal layer of the pleura, together with the intercostal wall, pressed by the fingers into contact with the diaphragm. (D) Incision in the diaphragm.

Do not be unnecessarily afraid of a possible pneumothorax; the incision is placed very low down; the costophrenic pleural *cul-de-sac* is filled and closed by the large swelling which pushes up and distends the diaphragm; there is no tendency for the air to rush in violently by the opening, and the necessary precautions can therefore be taken without haste. Let an assistant apply his fingers—or the operator may apply his own left fingers—to the wall in the manner shown in *Fig.* 439, so that they depress the soft intercostal tissues immediately above the parietal incision into contact with the arched surface of the diaphragm; this manœuvre will prevent access to the pleural cavity, not only of the air, but also, and more important, of the contents of the deep-seated cavity, which might rupture suddenly before the needed preparations are made.

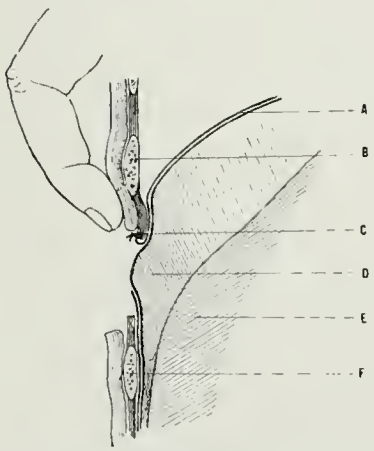


Fig. 440.—Transpleural incision of a subphrenic abscess (diagrammatic). (A) Diaphragm. (B) 8th rib. (C) Upper portion of the intercostal wall and parietal pleura, pressed down by the finger into contact with the diaphragm. (D) Subphrenic abscess. (E) Liver. (F) 10th rib.

Before going any further, *this temporary occlusion must be made permanent* by suturing the two layers, parietal and diaphragmatic, together.

Incise the serous covering, and a little of the muscular fibres of the diaphragm, in the manner shown in *Fig.* 439, and raise a short flap, which will then be united by a continuous suture or a row of interrupted sutures to the upper lip of the parietal incision.

In addition also, using a curved needle, introduce a series of U-sutures, on the one hand including a sufficient thickness of the diaphragm, on the other passed through the parietal flap, and in this manner bring broad surfaces into contact.

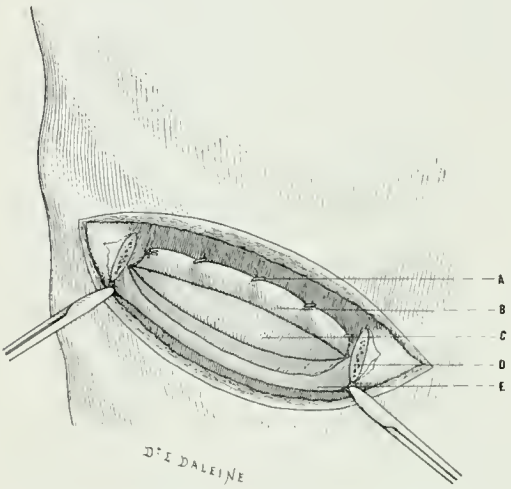


Fig. 441.—Transpleural incision of a subphrenic abscess; the diaphragm has been incised and sutured to the edges of the parietal incision. (A) Suture of the upper lip of the diaphragmatic incision to the thoracic wall; *permanent closure of the pleural cavity.* (B) Upper surface of the diaphragm. (C) Convex surface of the liver. (D) Anterior extremity of the resected 9th rib. (E) Lower lip of the parietal incision.

These preliminary steps must always be carried out with the greatest caution, particularly when a fluid accumulation, evidently ready to burst out, is felt below the diaphragm, and during the suturing the compressing fingers which close the entrance to the pleura above must be kept constantly in position. If the pus should begin to escape before the precautions are complete, at once open the cavity freely, and by means of the fingers introduced through the incision, press the diaphragm firmly against the deep surface of the thoracic wall, and suture it as soon as the first stream of pus has escaped.

In cases where the abscess is very tense, and danger of rupture is imminent, it will often be better to make a preliminary aspirating puncture, and when the diaphragm is somewhat relaxed, to introduce the necessary sutures and then to open up the cavity.

Fig. 442.—Continuous retrograde suture (*steppsutur*) for attaching edges of opening in diaphragm to parieties, marsupialization of cyst walls, etc.

In other cases, where the abscess is situated within the liver, the incision can be carried through the entire thickness of the diaphragm at once, and the edges of the opening sutured to the lips of the parietal wound (*Figs.* 441, 442). Whatever may be the procedure rendered necessary by the circumstances, on no account must adequate provision for the protection of the pleural cavity be omitted. After the pleura is properly closed, in front and behind,

it becomes possible to proceed with confidence to empty and drain the abscess.

I need only mention that opening the diaphragm may reveal a **simple subphrenic abscess** or a **subphrenic abscess in communication with an intra-hepatic focus**, or an **intra-hepatic abscess**, simple or loculated, still completely enclosed within the liver tissue, and which will be opened in the manner already described; finally there may be a **hepato-suprahepatic abscess** communicating through the diaphragm with an **encysted pleural, pulmonary, or mediastinal focus** (gourd-shaped abscess), which must likewise be opened up as freely as possible, cleansed, and drained

III.—PERINEPHRITIC ABSCESS.

A man, 36 years of age, after a tiring day, was taken with pain in the "kidney" region, some shivering and fever, and went to bed. The trouble was at first thought to be a simple "sprain of the back," and treatment was instituted on appropriate lines; however, the pain became more severe, and localized itself definitely to the left side; the fever continued and rose higher, the general condition became worse, but the urine remained normal. On the fifteenth day the patient was admitted to hospital; his condition was then as follows: the temperature ranged from 101° to 103°, the tongue was dirty and whitish-yellow, the face pale and pinched; there were no peritoneal signs, everything being limited to the left flank and lumbar region. By bimanual palpation, with the right hand under the loin and the other applied in front on the flank, it was easily recognized that the whole region between the lower ribs and the crest of the ilium was occupied by a large, painful fluctuating mass. When the patient was turned on to his right side, it was at once evident that the left lumbar region presented a well-marked fullness, and that there was a prominent rounded swelling at its central part; over this swelling the skin was somewhat reddened, and retained the impress of the examining finger, and quite superficial fluctuation was obtained.

Perinephritic abscess, bilocular, with subcutaneous and deep pockets; such was the quite evident diagnosis—and one which demanded immediate operation. A long vertical incision was made over the lumbar swelling; under the thickened skin, a large abscess was opened, and as soon as the first stream of pus had escaped, *an elongated opening*, through which three fingers could be passed, was recognized in the deep wall of the cavity at the outer border of the erector spinæ muscle; from this opening the pus continued to flow. It was the orifice of the channel whereby the perirenal abscess had made its way to the subcutaneous tissues.

The channel was enlarged with the finger, and a fresh stream of pus escaped. The cavity was irrigated with boiled water. It was then possible to determine the relationships of the deep pocket; this occupied the entire vertical extent of the flank, was closed in all directions, and was traversed from above downwards by a number of bands; the kidney was felt with

difficulty, and was found displaced forwards to the front of the abscess cavity.

In the cases of this kind—and they are not very uncommon—operation is nothing more than the incision of a subcutaneous abscess. One point alone demands attention: it is always necessary to look for the transparietal opening, which is sometimes rather small and valvular, to penetrate into the channel of communication, and to enlarge it with the fingers or scissors down to the level of the dependent part of the deep pocket; this is the only way to insure satisfactory drainage and speedy healing of the cavity.

But one should never see such extensive suppuration nor wait till a perirenal abscess approaches the surface. The febrile symptoms, the localized pain, and the results of bimanual examination which discovers a thick, diffuse, deeply fluctuating mass filling up the lumbar region, are amply sufficient data on which to base the diagnosis.

The mass must be incised, and it must be done as follows: Have the patient laid on the opposite side, with the back in a good light; quickly determine the positions of the 12th rib, the iliac crest, and the line of the spinous processes; make a slightly oblique incision commencing at or just below the 12th rib, 4 inches from the spinous processes and descending almost to the iliac crest (see *Fig.* 327); divide the skin, the subcutaneous tissue—which is often œdematous,—the superficial aponeurosis, and work from behind forwards, without troubling much about the various layers that are traversed, but keeping always in touch with the outer border of the erector spinæ, towards the deep-seated, tense, almost hard mass, which becomes more and more definite as it is approached. Do not be alarmed by the size of the enormous opening which it is sometimes necessary to make; by keeping to the first direction, there is nothing to fear, and the practitioner may work steadily forwards towards the tumour. Not seldom one or two lumbar arteries may be cut: these must be caught with forceps.

After the pus is reached, do not omit to enlarge the opening, **particularly downwards.** Very free opening of the deep abscess is necessary, but, on the other hand, interference with the interior of the cavity is both useless and dangerous. Let the pus escape, cleanse the cavity carefully with gauze swabs in holders, then explore it rapidly with the finger, and make sure there is no diverticulum, no ill-drained cul-de-sac; but limit the interference to this simple investigation; do not attempt to rupture the intersecting bands (which may bleed badly), nor to "put the cavity in order"; simply drain it. **Drain with two large tubes,** arranged to penetrate right to the bottom of the cavity, and fixed to the edge of the wound by a couple of sutures; leave the wound widely open, at the most putting in one or two points of suture at the extremities if the incision is very long.

Remember that the discharge is usually very considerable during the first few days; therefore apply a very thick dressing, and be prepared to change it if a stain comes through.

The lumbar incision remains absolutely essential and urgent, even when there has been a discharge of pus by the anus or by the respiratory tract.

Case 61.—A woman, 40 years of age, had been very suddenly taken ill eight days previously, with pain in the right flank, shivering, and fever; a diagnosis of perinephritic abscess had been made, and a profuse discharge of pus had occurred by way of the respiratory tract. A large mass was still felt in the right renal region. The temperature, which had fallen after the discharge of pus by the vomica, rose again on the following day, and some days later a lumbar incision opened into an enormous cavity which extended to the diaphragm, the perforation in which could not, however, be discovered. After irrigation and drainage, recovery ensued without any untoward symptoms.

The above rule holds good for all deep-seated suppurations, and though evacuation by a visceral route, by the alimentary canal, or the respiratory tract is sometimes a fortunate accident in cases of doubtful diagnosis or where access to the suppurating focus is very difficult, this is never an issue either to be looked for or considered as curative.

In addition to these perinephritic abscesses of the classical type, there are other acute suppurations, occurring in the same region, which also require early operation; I refer to the **prerenal abscesses** and the **pyonephroses.**

Some accumulations in the perinephritic region develop entirely *in front, in the flank*, and it is in front they must be opened.

There can be no doubt that these prerenal suppurations are of various origins; some of them simply represent the common perinephritic abscess abnormally placed, while others are of appendicular,[1] pancreatic, or renal source.

Case 62.—A girl, 17 years of age, was admitted into my hospital service with high fever (103°), pale, worn face, and acute pain in the right flank, where a large swelling could be felt. The symptoms were of a fortnight's duration; there was nothing abnormal in the urine, and there were no peritoneal symptoms. The swelling was globular, projecting forwards and evidently distinct from the lower border of the liver; it occupied the whole of the right flank, was tense, painful, and doubtfully fluctuating; on bimanual palpation, it could be felt posteriorly in the lumbar region, but much less definitely than in front. A vertical incision was made in the right flank, parallel to the outer border of the rectus muscle; I opened into the free peritoneal cavity, and immediately discovered a large rounded swelling, reddened and fluctuating, covered by the right layer of the mesocolon, and which evidently occupied the right kidney; by a series of catgut U-sutures, I united the surface of the tumour to the abdominal wall, in this manner circumscribing and isolating an area of the general serous cavity; a vertical incision within this area, after traversing a layer of renal tissue about ½ inch in thickness, opened into an abscess cavity containing about 8 oz. of pus. The edges of the renal incision were attached to the skin by a few sutures, and the cavity drained by means of two large tubes. Rapid recovery followed.

[1] We have already related an instance of appendicular origin (see Appendicitis).

Whatever may be the pathogeny and exact situation of these purulent accumulations in the flank, renal or prerenal, the technique of the operation depends essentially on whether the **swelling is or is not adherent to the abdominal wall**; a careful local examination will often permit this point to be determined in advance. Make a vertical latero-abdominal incision over the tumour, in the line of its chief axis; divide the skin, the subcutaneous fatty tissue, the superficial aponeurosis, and the muscular layers. If the tumour is adherent (and one will now be able to make sure of this), it will be opened directly by incising the deep fibrous layer of the abdominal wall, and be treated as an ordinary abscess.

At other times, after having carefully divided the fibro-serous layer through a raised-up fold, *the free peritoneal cavity* is entered, and the reddened surface of the swelling is found covered by the posterior peritoneum; before going any further, protect the general cavity by uniting the anterior and posterior serous layers by means of a series of catgut sutures; in this manner, the central, projecting part of the swelling will be isolated, above, below, and to the inner side, and may now be incised. After evacuation of the contents, the "marsupialization" of the pouch will be completed by suturing its edges, which are often thick and always friable, to the skin.

This same procedure of marsupialization should also be employed when dealing with a **pyonephrosis** from behind by *the usual lumbar incision;* but in that case it is a much simpler matter, the peritoneum being absent.

Case 63.—A young woman was sent to us from the medical wards in a very serious condition, with fever, bad pulse, earthy-coloured skin, dry tongue, pus in the urine, and pains in the right renal region. In that situation a large, lobulated, tender swelling was felt; it was as accessible by the flank as by the lumbar region, and owing to the emaciated condition of the patient, it was very easily palpated and recognized. It was a large suppurating kidney; renal symptoms had been present for some months, but subsequent to a recent confinement they had undergone a marked aggravation. Nothing abnormal was found on examination of the opposite kidney.

Nephrotomy was urgent. The usual oblique lumbar incision was made, the fatty capsule was opened, and the lobulated, fluctuating surface of a large kidney was at once exposed. The organ was pushed up into the wound by the hand of an assistant applied to the flank; it was surrounded by compresses and incised longitudinally on the convex border. A great quantity of grumous pus mixed with urine escaped. The margins of the opening into the renal cavity were united to the musculo-aponeurotic edges of the parietal incision by four catgut sutures, and the cavity drained.

On a fat patient the operation may become very difficult; the difficulties will be overcome, however, by putting the patient in proper position, making a very long and well-placed incision, and deepening it steadily from behind forwards to whatever depth is necessary, down to the perirenal fat. Before incising the abscess, care should be taken to push the kidney as far backwards into the wound as possible, and, after the cavity has been evacuated, the edges will be fixed to the parieties and the wound will be left widely open.

Of course, I am here speaking only of the cases in which nephrotomy is required as an immediate operation, without laying any stress on ultimate results or referring to any secondary operations which may become necessary.[1]

IV. HYPOGASTRIC ABSCESS.

A few words only with regard to these rare abscesses, which may spring from very varied sources: suppurative pericystitis, appendicitis, or disease of the uterine appendages. They usually present very characteristic appearances; there is an exactly median, tense, globular swelling (*Fig.* 443), bounded above by an arched border situated more or less near the umbilicus, and extending on either side to the limits of the sheaths of the recti muscles. The appearance very closely simulates a distended bladder; the mistake has been made, and care should always be taken to empty the bladder before any examination.[2]

Fig. 443.—Abscess in the space of Retzius.

The swelling extends in a downward direction behind the pubes; on rectal examination it can be felt more or less definitely, depressing the anterior rectal wall (*Fig.* 444). There is deep fluctuation, and all examinations cause acute pain; the skin in the hypogastric region, at first free and mobile, becomes after some time œdematous and reddened, indicating the approach of the underlying suppuration.

Complete the investigation by careful palpation of the adjoining regions—particularly the right iliac fossa, where tenderness at McBurney's point will sometimes indicate an appendicular origin for the hypogastric abscess[3]—and in female patients, by vaginal examination.

Whatever the probable point of origin, the incision of the abscess will always be the same: **median, vertical, following the linea alba**

[1] See A. Gosset's excellent thesis, *Étude sur les Pyonéphroses*, 1900.

[2] I was summoned one day in great haste to see a patient suffering, I was told, from a large abscess in the space of Retzius. I found a lad, looking very ill, with some fever, abdominal pains, and a large, tense, and tender swelling in the hypogastric region; "he had frequent and painful desires to urinate, but passed very little." However, on passing a catheter about 6 pints of urine were drawn off, and the swelling immediately disappeared. The condition was one of febrile gastric disturbance associated with retention of urine, and the doctor had been misled by the overflow from the distended bladder. When there is a rounded median tumour in the hypogastric region, one must always think first *of a distended bladder or a gravid uterus.*

[3] See Tuffier, "Abcès prévésicaux par appendicite." *Semaine médicale*, 1894, p. 557. Schwartz, Monod, and Brun have also reported cases.

from the pubes upwards for 3 or 4 inches. One must expect to traverse a *very thick mass* of tissue, and delay in trying to recognize the various planes is unnecessary; the important point is to keep to the middle line. Therefore cut down boldly, from before backwards, deepening the incision steadily without dissecting, dividing the skin, a dense fibro-cellular layer, a thick fibrous layer (the linea alba or the inner border of one of the recti sheaths), a second, dense, fibrous layer, œdematous and yellowish in colour; puncture the abscess close to the pubes, and open it from below upwards.

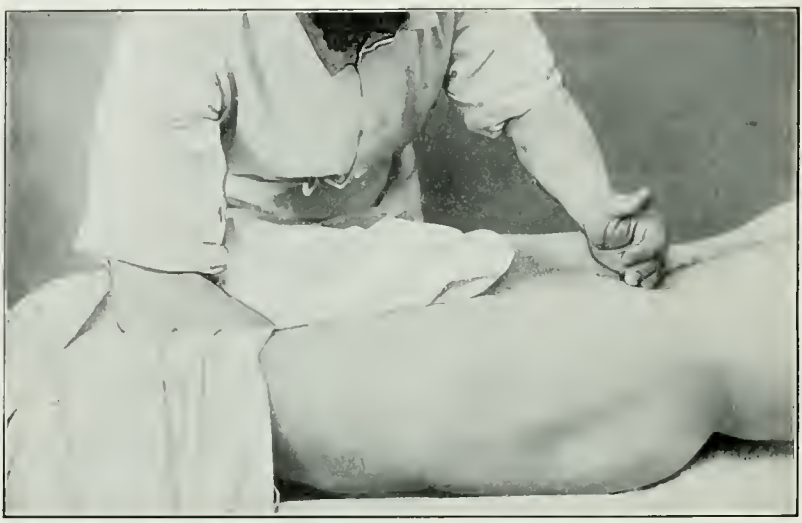


Fig. 444.—Bimanual examination of a hypogastric abscess by combined abdominal and rectal palpation.

Then, by retracting the edges of the opening, the walls of the prevesical cavity and any possible diverticula will be examined, and possibly the original focus may now be dealt with.

V.—ABSCESSES OF THE ILIAC FOSSÆ.

We shall not revert to the question of pericæcal abscesses (see APPENDICITIS): here we have particularly in view **those abscesses of the iliac fossa due to utero-tubal infection after confinement or miscarriage.**

It is not superfluous to insist on the fact that the opening of these abscesses is an urgent matter which ought to be undertaken without delay as soon as there are certain signs of the presence of pus. The following case will serve to emphasize this simple rule, which is often disregarded in practice.

I once made an autopsy on a woman, about 40 years of age, who had been admitted to hospital for "sciatica," with pains situated exactly along

the track of the nerve behind the thigh and the knee. However, on examination, *a diffuse mass* was discovered, filling the right iliac fossa and partly masked by the extreme adiposity and œdema of the abdominal wall. The uterus was enlarged, the os patulous, and from it a fœtid discharge was escaping; the temperature was 101°. The patient died suddenly just as operation was about to be performed. I have seldom seen so much pus in an abdomen as there was in this case; the iliac fossa and the pelvis were full, and a wide track passed through the sciatic notch to the posterior aspect of the thigh and down to the popliteal space. Further, the external iliac vein contained a considerable quantity of pus, and there were multiple small emboli scattered throughout both lungs.

Why are these iliac abscesses so often allowed to acquire such dimensions? Simply because one waits too long for definite fluctuation, which is usually very slow in appearing. In its initial stages an iliac abscess presents itself, and remains for a long time, in the form of a diffuse, infiltrated, hard mass; when associated with fever, pain, and sometimes with œdema of the overlying wall, this diffuse induration is a sufficient indication of the presence of pus.

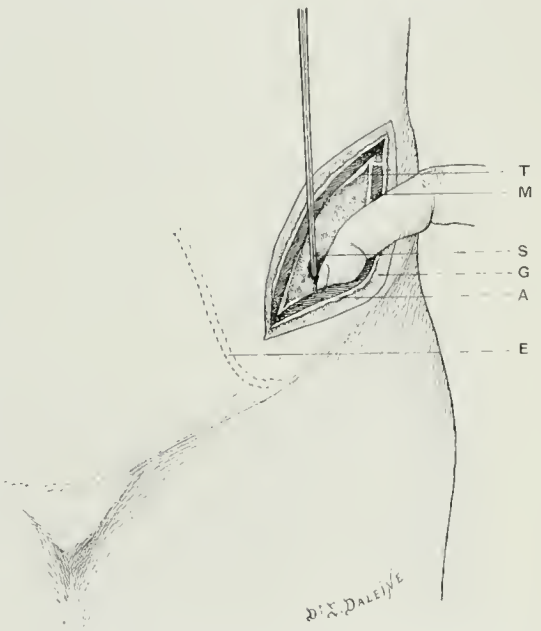


Fig. 445.—Incision of an iliac abscess. The finger and the director are separating and raising the œdematous extraperitoneal fatty tissue from below upwards. (T) Fascia transversalis. (M) Muscular layer. (S) Director and finger pursuing the search for the deep-seated abscess. (G) Subcutaneous fatty tissue. (A) Aponeurosis of the external oblique. (E) Track of the deep epigastric artery.

Therefore make an incision without delay: the large quantity of pus which is contained in the abscess is always astonishing.

The incision will be made **about two fingers' breadth above and parallel to the outer half of Poupart's ligament**; begin the incision on the left side, above the middle of the ligament, and carry it upwards and outwards to the level of the antero-superior iliac spine (*Fig.* 445).

Remember that the deep epigastric vessels cross the deep surface of Poupart's ligament at a finger's breadth internal to its mid-point; by not going beyond the inner limit we have just indicated, and by first opening the deep layer of the wall at the centre of the line of incision, all risk of injuring these vessels will be avoided.

In any case, even if the epigastric artery is divided, the occurrence need cause no alarm; two pairs of forceps applied to the two ends and immediately replaced by ligatures will set matters right at once; therefore, if the cavity extends in any degree inwards, do not hesitate to extend the incision in that direction. It may happen, however, that when the wall is infiltrated and œdematous there may be some difficulty in seizing and ligating the vessels directly, it may then be necessary to include the tissues immediately surrounding the vessels in the forceps and ligatures.

Therefore divide the various planes of the wall boldly; even if there is much œdema of the subcutaneous tissue, *the white aponeurosis of the external oblique is always recognizable* and will serve as a landmark; incise it, in its turn, in the line of its fibres, from one end of the wound to the other; then lay the scalpel aside.

Sometimes the sub-aponeurotic layers are so infiltrated that the slightest effort of the finger suffices to open into the abscess, which is already on the way to rupture spontaneously.

But I assume that the operation is performed at a comparatively early stage. With the tip of the finger and the director, insinuated under the lower edge of the divided aponeurosis, separate the inferior border of the muscular layer and displace it upwards; now tear through the deep fibrous lamina, the fascia transversalis, introducing the end of the director, *below and behind, close to Poupart's ligament* (*Fig.* 445). Usually the abscess cavity will be opened during the course of this manœuvre, the pus will begin to escape, and it only remains to enlarge the opening with the finger. At other times, after tearing through the fascia transversalis, the œdematous extraperitoneal fatty tissue will be penetrated into, and little difficulty will be experienced in continuing the dissection with the finger or the director, *towards the pelvis*, and thus raising the peritoneal reflection, which usually will not even be seen.

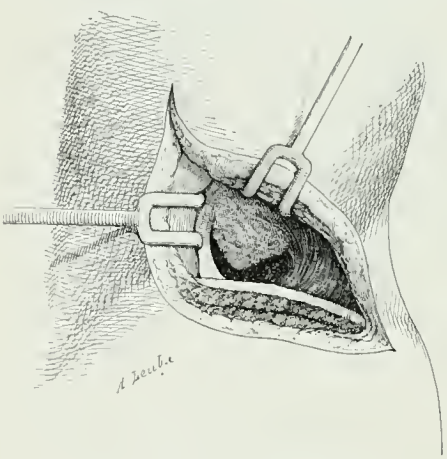


Fig. 446.—Incision of an ileo-lumbar abscess.

In addition to ilio-pelvic abscesses, it is necessary to mention those iliac accumulations which are situated at a higher level, **the ilio-lumbar abscesses.** The incision in front has been made, and, after having opened the abscess, the cavity is seen ascending for a considerable distance behind the colon, ascending or descending according to the side, to the confines of the perirenal zone; if the cavity is very large, and extends towards the spine, it will very often be advisable to make a counter-opening for drainage, posteriorly above the iliac crest. The low-seated lumbar abscesses

ought to be opened at the same posterior point, at which indeed they tend to come to the surface.

Case 64.—A woman, 52 years of age, was sent to me with a large swelling in the lower left lumbar region, with persistently high fever and in a very bad general condition; the deep-seated mass, which extended downwards to the crest of the ilium, was fluctuating and resonant; I opened it by the posterior incision shown in *Fig.* 446; some gas and an enormous quantity of pus escaped, and I penetrated into a very large cavity, which extended upwards almost to the kidney and below into the iliac fossa. It was drained, and the patient recovered.

These abscesses are usually due to suppurative pericolitis, the primary cause of which may have been a small perforation of the colon or sigmoid flexure, or they may originate around a new growth.

With the patient in the ventral decubitus, the incision is made along the crest of the ilium to the outer border of the erector spinæ, and is then carried upwards along that border, which will serve as a landmark, while one continues to work from behind forward, following the muscle border towards the deep-seated mass (*Fig.* 446).

After all these operations, free drainage must be provided by means of tubes: never use gauze, which simply becomes saturated with pus and acts as a plug.[1]

ACUTE CONDITIONS DUE TO THE TORSION OF PEDICLES.

The following is a typical example of the severe shock which is often associated with the torsion of a pedicle:—

Case 65.—A woman, 33 years of age, was taken suddenly, in the morning while in bed, with most intense pain in the abdomen, and fainted. With considerable difficulty she was restored to consciousness and rallied a little, but the pulse remained exceedingly bad, respiration very feeble, and the abdomen was distended and extremely sensitive. Throughout the day intravenous and subcutaneous injections of saline solution were repeatedly administered: towards the evening the immediate danger of a fatal issue seemed at last to be overcome, though the abdomen was still distended and sensitive, but there was no vomiting, nor any signs of grave peritoneal reaction.

The situation improved very slowly without the appearance of any urgent symptom demanding immediate operative measures. The abdomen having lost its initial tension and—in some degree—its sensitiveness, an adequate examination became possible *and a large tumour was discovered, occupying the whole of the subumbilical region and extending upwards towards the left hypochondrium.* The outlines of the mass were ill-defined; it was of very firm consistence and gave a doubtful sensation of deep fluctuation. On vaginal examination the uterus was found to be enlarged and surrounded posteriorly and on the right

[1] When the iliac abscess extends very low down, abdomino-vaginal drainage may be indicated; if so, then posterior colpotomy should be performed, instead of puncturing Douglas' pouch on the finger and incurring the risks of a rectal or vesical perforation. (See Urgent Colpotomy.)

side by a doughy mass; the lower pole of the abdominal tumour could not be felt. The examination was rendered very difficult by the still persisting pain, which was aggravated by the pressure.

I performed laparotomy, and found a large ovarian cyst, situated high up in the left flank and *universally adherent to the omentum and the abdominal wall*: it was blackish in colour and evidently full of blood; I punctured it, and evacuated about 3 pints of black, hæmatic fluid; the flow then ceased, although the cystic tumour was still large; I then incised its anterior wall, after having surrounded the cyst with aseptic compresses, and removed a large quantity of clots.

The sac was separated, drawn outside the abdomen, and the pedicle then became accessible; it was twisted three times on itself, from right to left, black and swollen, adherent to the neighbouring intestinal coils and to the external iliac artery: it was liberated, ligated, and cut.

There were several small fibromata in the uterus, while the right appendages formed a cystic mass which was prolapsed to the bottom of Douglas' pouch; but as the state of the patient rendered a speedy termination of the operation necessary, we considered it advisable simply to limit ourselves to the removal of the twisted cyst, leaving the uterus and the right appendages to be subsequently removed by vaginal section if necessary. The bleeding area where the adhesions had been separated was dried with gauze swabs and a Mickulicz drain introduced. An uneventful recovery ensued.

In this case, notwithstanding the intensity of the initial symptoms, the hæmorrhage had been entirely intracystic; no rupture had occurred, and there had been no signs of septic peritonitis; but one can easily understand that under other circumstances the only chance of recovery might lie in an immediate operation.

Torsion may occur on the pedicle of an **ovarian cyst**, of a **uterine fibroid**, of a **tubo-ovarian tumour**,[1] on the pedicle of a **mobile spleen**, and lastly on the **great omentum**.[2]

Sudden torsion—the only variety we have here in view, and which alone gives rise to urgent indications—always announces itself by **severe and sudden pain**, accompanied by more or less marked shock; this pain is never lacking; it is characteristic.

The succeeding symptoms may be indicative of *continued and serious hæmorrhage*, of *intestinal obstruction*, or of *peritonitis*.

The great practical importance of grouping together and comparing all these abdominal accidents of acute onset, is at once evident: *ileus*, *peritonitis by perforation*, *rupture of an extra-uterine pregnancy*, *hyperacute perforating appendicitis*, *torsion of pedicles*, conditions which must always

[1] Tubal torsions are more common than had been thought: I have myself seen eight cases during the past few years. It is usually a hydrosalpinx which is affected; M. F. Cathelin, in an important paper, has collected 35 cases, in which he has reviewed the whole subject, and has formulated an attractive theory as to their etiology. ("La torsion des hydrosalpinx. *Revue de chirurgie*, février, 1901, No. 2, p. 253.)

[2] Torsion may also affect *the appendix*, *Meckel's diverticulum*, the *gall-bladder* (R. Mühren "Stieldrehung der Gallenblase." *Berliner klin. Woch.*, 22 June, 1908, No. 25, p. 1179), *some pedunculated myomata* or *lipomata of the intestine*, and *mesenteric tumours and cysts*. This last variety—though uncommon—is very serious, because the mesenteric torsion involves torsion of the intestine and true intestinal obstruction. (See E. Payr. "Ueber die Ursachen der Stieldrehung intraperitoneal gelegener Organe." *Arch. f. klin. Chir.*, 1902, Bd. lxviii., p. 581.)

be thought of, which may present themselves with quite similar appearances, and in which the diagnosis may be exceedingly uncertain, but which all demand the same action, the same urgent operation, without hesitation and without delay.

Cases of rapid death from **hæmorrhage**, subsequent to torsion of the pedicle of an ovarian cyst, are by no means exceptional. "One day," wrote Spencer Wells, "I arrived at Brixton with Mr. Bowler, of Kensington, to operate on a lady, and learned that she had died suddenly two hours before our arrival. The post-mortem examination showed that death had been due to an enormous extravasation of blood, which had taken place first of all into the ovarian cyst, and then, after rupture, into the abdominal cavity, and which had evidently resulted from the torsion of the pedicle, produced by rotation of the non-adherent cyst." I have myself seen a patient succumb suddenly under quite similar circumstances.

In somewhat less severe cases the accident is characterized by all the signs of **serious internal hæmorrhage**: weakness and progressive enfeeblement of the pulse, coldness of the extremities, subnormal temperature, syncope; in fact, the condition is exactly similar to that which follows the rupture of an ectopic gestation, and immediate laparotomy is equally urgent.[1]

Sometimes the torsion presents itself under the guise of **intestinal obstruction**, or more frequently, **pseudo-obstruction**. Neither fæcal matter nor flatus is passed; there is vomiting, which speedily becomes fœtid, blackish, and even fæculent, with distention of the abdomen; all the symptoms of obstruction are present, and suggest internal strangulation or a volvulus.

This clinical type may present itself in cases of *acute torsion of a tubo-ovarian mass* as well as in torsion of a cyst or fibroid; an instance reported by Pierre Delbet[2] furnishes an excellent illustration: a woman, 39 years of age, while walking in the street, was suddenly seized with an intense pain in the left iliac region. "The pain was so severe that she fainted and fell. She was picked up and taken to the Charité . . . . On the way, vomiting began and continued all night and into the next day. I saw her about midday. Vomiting had then occurred about a score of times, but was not fæcal. Neither fæces nor flatus had been passed per rectum . . . . the face was flushed, pulse fairly good though rather fast, temperature normal, and the abdomen was retracted rather than distended. The spontaneous pains had remained strictly localized to the left iliac region, and were so much increased by any attempts at palpation that adequate examination was impossible. *The signs of obstruction were very definite*:

[1] See M. C. Daniel's article, "Les hémorragies de kystes tordus de l'ovaire." *Revue de chirurgie*, oct., 1905, p. 479. The bleeding may take place into the wall of the cyst, into the cavity (usually), into the wall and the cavity, or lastly, after rupture, into the free peritoneal cavity. In 40 cases collected by M. Daniel there were 10 deaths (25 per cent), of which 4 were due to fulminating intracystic hæmorrhage and 2 to rupture and intraperitoneal hæmorrhage.

[2] Delbet, *Bull. de la Soc. anat.*, 1892, p. 300.

vomiting, absence of fæcal movement or passage of flatus. As the onset had been very sudden and severe, I thought that it was probably due to strangulation by a band, or possibly a volvulus." Laparotomy was immediately practised. The peritoneum was opened and a hand slipped first into the left iliac fossa and then into the pelvis; after a few slightly adherent loops of bowel had been displaced, a tumour was felt, and was brought outside the wound without difficulty. It was absolutely black, composed of two closely apposed parts, and looked almost like a loop of intestine, the two ends of which were adhering by their mesenteric borders. The pedicle was very thin, about the diameter of the little finger, and the spiral twist indicating *a torsion* could be seen quite plainly. I believed at first that I had to do with a volvulus, and set myself to untwist it; but, having given the tumour three half-turns, and finding no sign of any re-establishment of the circulation, while the pedicle still remained very small, I recognized that the mass was really attached to the left uterine cornu, and therefore removed it, after having ligated and divided the pedicle. It was a large tube full of blood. The patient recovered without any complication.

Further, it may happen, in cases of this kind, that the symptoms of obstruction are really due to *a mechanical interference* with the movement of the intestinal contents, from the pressure of the greatly swollen mass impacted in the pelvis, or from the fixation or torsion of neighbouring and adherent loops of intestine.[1] Usually, however, the evolution of the symptoms is that of *pseudo-obstruction*: the fæcal stoppage is incomplete, the vomiting has no special character, but is persistent; the pain continues, abdominal distention increases gradually, the general state becomes steadily worse, and operative indications ultimately become urgent owing to the continuance or recurrence of the vomiting and the appearance of symptoms of septic absorption.

Finally, torsion is most often associated with **peritonitic reactions**, usually comparatively mild and protracted, but which may quickly assume the characters of acute peritonitis. The peritonitis may manifest itself at once owing to the *rupture of a cyst*[2] with septic contents, but usually it develops more slowly, consequent on gangrene and suppuration of the cyst leading to a true peritoneal septicæmia.

The vital importance of not delaying until gangrene, and consequent

[1] See a case of Remy's, of Cincinnati (*Medical News*, vol. 2, p. 299), reported in Bénard's thesis, *Contribution à l'étude de la torsion du pédicule des kystes de l'ovaire et en particulier de l'occlusion intestinale consécutive à cette torsion.* Thèse de doct., 1898, No. 379.

[2] Apart from ruptures of cysts consequent on torsion of pedicles, it is necessary to mention here the *traumatic ruptures* caused by external violence (falls, kicks, etc.), sometimes by various exploratory manipulations, massage, etc.

The accident is by no means so often indicated by symptoms as characteristic as those associated with torsion of the pedicle: the flattening of the abdomen and sudden diminution in size of the tumour are the most useful signs: the peritoneal reactions naturally vary according to the nature and septicity of the cyst contents. However that may be, in such cases laparotomy must be considered as urgently necessary, with the objects of evacuating the extravasated fluid, extirpating the cyst, and cleansing the peritoneum. Commencing or already established peritonitis only renders the indications more urgent. (See Émile Arnal, *De l'intervention chirurgicale dans la rupture traumatique des kystes de l'ovaire.* Thèse de doct., 1898, No. 454.)

generalization of the infection, occurs, is evident. A young woman, 23 years of age, and three months pregnant, was seized on January 7th, 1893, while in perfect health, with violent abdominal pains and vomiting; the latter, which was at first alimentary, then bilious, continued almost incessantly from the onset until the 11th. A diagnosis of peritonitis, possibly due to perityphlitis, was at first made, and expectant treatment instituted. In spite of everything, however, the condition steadily became worse; abdominal pain and vomiting continued, the abdomen became distended, and, wrote M. Bouilly, "I was summoned to see the patient on the 12th. She presented very typically all the classical signs of acute general peritonitis, with Hippocratic facies, feeble pulse, etc. The abdomen was greatly distended, particularly in the sub-umbilical region, and very sensitive to palpation. The following details could be made out by the examination:—

"In the hypogastric region there is a median tumour, extending chiefly to the right, fluctuating, very tender and immobile; it can also be felt in anterior vaginal fornix. Behind this tumour, which extends almost up to the umbilicus, another can be felt, occupying a slightly lower level, inclined to the right, and evidently continuous with the neck of the uterus. It was therefore easy to recognize a cyst displaced forwards and to the middle line, and an enlarged pregnant uterus, situated behind the cyst and inclined to the right. I at once made the diagnosis of torsion of the pedicle, and recognized the need for operation as soon as possible." Laparotomy. The cyst wall was black and infiltrated with blood; about 1½ pints of blood-stained fluid were removed by aspiration, and the sac having been brought outside, it was found that the pedicle had been subjected to very pronounced torsion, and was much shortened and infiltrated with blood. It was necessary to turn the cyst one and a half times around its axis from left to right before the pedicle was untwisted and straightened out; the twist was therefore from right to left, and represented one and a half turns of a spiral. The patient recovered, and the pregnancy pursued its normal course.[1]

At other times the sudden onset of the attack primarily suggests **appendicular perforation.** A woman, 50 years of age, was suddenly seized with intense pain in the right flank, which rapidly spread over the whole abdomen. Vomiting appeared at the same time, the vomited matter being at first bilious, but soon becoming intestinal. The pulse was small, fast, and a little irregular, but there was no rise of temperature.

In the face of these symptoms, the first thought was of appendicitis, but the patient mentioned a consultation twenty-two years before with Constantin Paul, who had diagnosed the presence of a dermoid cyst. The presumption then was that the symptoms were due to a twisted pedicle, an opinion which the physical examination confirmed. The abdomen was distended and painful on pressure; the pain was diffuse and acute, and

[1] This case is reported in Paul Baron's thesis. *Torsion du pédicule des kystes de l'ovaire*, 1898, obs. xviii. Here we may mention that torsion of the pedicle of an ovarian cyst frequently happens during pregnancy; it requires immediate operation, which, when performed with the necessary precautions and followed by the administration of morphine subcutaneously (Pinard), usually excites no uterine action.

somewhat relieved by deep pressure. On vaginal examination, the uterus was found to be mobile, of normal size, and displaced forwards; on its right side the lower pole of a tumour, about the size of the adult head, could be felt, and gave a sensation of unequal consistency, partly hard and partly soft. The operation, which was performed by Walther, showed that the tumour was in reality *a fibroid with a twisted pedicle.*[1]

The knowledge of the pre-existence of a pelvic tumour is a factor of considerable diagnostic importance, and the point should always be investigated with care. Often also *the sudden, tight torsion has been preceded by several milder crises*, due to *slow and incomplete torsion*; the patients have suffered for a variable period from indefinite abdominal pains, which from time to time have become more acute and been accompanied with distention and vomiting; subsequently all the symptoms have disappeared, or at least relapsed to the former chronic condition. In cases where, during the performance of ovariotomy, we have observed torsion of the pedicle,[2] the reports have invariably contained references to repeated attacks of this kind, the true nature of which had not been recognized.

The two following cases will serve very well to illustrate this intermittent evolution.

Case 66.—A woman, 40 years of age, was *suddenly* taken ill during the morning, while carrying out her household work, with pains in the lower abdomen; she vomited repeatedly, but the whole attack only lasted some hours. When admitted to our wards she was free from pain; in the right side of Douglas' pouch and high up we found a small, painless mass, about the size of an orange, mobile and smooth; there was nothing on the left side. At the end of some days, the patient, who felt quite well, asked to be discharged.

This first attack occurred on June 3rd. On the 19th, while alighting from a railway train, after a sudden movement the patient was attacked with similar pains to those experienced on the previous occasion, and vomiting; again the symptoms subsided at the end of some hours. Laparotomy was performed on the 21st; I found a blackish tumour, free except for a few adherent omental fringes; it was punctured, and 10 ounces of sero-sanguineous fluid escaped; I brought the sac outside, and then found it to be a dilated left tube with a twisted pedicle, on the posterior aspect of which there were slight traces of gangrene. The ovary had not been involved along with the tube in the torsion. The mass was removed. On the right side a hydrosalpinx slightly adherent to the bottom of Douglas' pouch was found and removed. A straightforward recovery followed.[3]

Case 67.—A more serious case. Patient aged 52 years; for a year there had been a gradual increase in the size of the abdomen, dragging pain and digestive disturbances, etc. Three months previously there had been a *sudden* attack of intense, tearing pain in the right side of the abdomen, followed by vomiting, and very alarming signs of peritonism which had lasted for a week. In December the pain recurred with its former suddenness; there was a little

[1] E. Planque, *Contribution à l'étude de la torsion des fibromes utérins.* Thèse de doct., 1897, obs. 2.

[2] According to Terrillon, torsion of the pedicle occurs in about 6 per cent of ovarian cysts, but the percentage would be considerably higher if the cases were included in which loose torsion occurs, without setting up complicating conditions in the cyst itself. (O. Terrillon, "De la torsion du pédicule des kystes de l'ovaire." *Revue de chirurgie*, 1887, t. vii.)

[3] The report and specimen have been submitted to the Société Anatomique by M. F. Cathelin: Salpingite gauche à pédicule tordu; hydrosalpinx droit prolabé; juillet, 1900.

vomiting without any special characters, nausea, constipation, abdominal distention; a drawn face, great diminution in the quantity of urine, pulse 100 to 110 and fairly good; no fever. Palpation caused great pain; it was, however, possible to feel a large, very tense, and resistant tumour which filled the whole of the subumbilical zone and extended on the left side almost up to the costal margin; the tumour was exclusively abdominal, and could scarcely be reached by vaginal examination; the uterus was small, and pushed forwards behind the pubes.

The symptoms rapidly became worse, the tumour appearing to enlarge still more and to become more tense. *A diagnosis of ovarian cyst with a twisted pedicle* was made, and laparotomy was accordingly performed. On opening the peritoneum, a notable quantity of reddish fluid escaped, and a large cyst was seen; its wall was black, thick, infiltrated, and attached by soft adhesions to the omentum and the abdominal wall; the cyst was punctured, and a quantity of reddish fluid, having the appearance of almost pure blood, was withdrawn. The sac wall was separated, and the whole mass brought outside the incision; the pedicle, which was as thick as a thumb, black and fissured, *was twisted twice on itself*. This was ligated and divided, the cyst removed, the pelvis wiped out, and the abdomen completely closed. Healing took place without the slightest untoward incident.

While the acute symptoms are present, the examination of the abdomen is sometimes rendered very difficult by the pain and distention; further, some tumours of moderate size, such as a pedunculated fibroid or a hydrosalpinx, may under these conditions be mistaken for a volvulus, an intussusception, or an intestinal loop, paralyzed and dilated above an obstruction.

The high position, exclusively abdominal, of the cyst or fibroid is a valuable diagnostic factor. It may also be a cause of error when no anatomical connection can be made out between the tumour and the pelvic organs.

Case 68.—A woman, 57 years of age, was brought to the Hospital Beaujon in a very serious state on May 10th, 1896; for three days the bowels had not moved, nor had flatus been passed; there had been frequent vomiting of greenish, fœtid material, the pulse was rapid and weak, temperature 100°, and face pinched; the symptoms had begun suddenly, without apparent cause; but the patient had suffered for a long time with pain in the right iliac region, and for five years had been subject to prolonged and obstinate attacks of constipation followed by diarrhœa. We could get no other information.

In the right iliac fossa we felt a hard, rounded, fixed mass, the size of two fists and extremely tender; *it was impossible to reach the tumour by the vagina*; the uterus appeared to be of normal size, and the examination of the fornices gave negative results. It was impossible to come to any conclusion as to the exact nature of the iliac tumour, but the immediate necessity for operation was none the less evident.

Infra-umbilical laparotomy was performed the same day; we found a cyst of the right ovary universally adherent to the small intestine and the cæcum; the wall of the cyst was covered with small, blackish and gangrenous patches, and the contents were purulent; it was attached to the uterine cornu by a pedicle, the thickness of a finger, which was twisted several times on itself and gangrenous in the greater part of its length. The tumour was enucleated and removed, and the cavity which it had occupied was carefully cleansed with gauze swabs and drained. After a period of improvement which led us to believe the patient might recover, death ensued from exhaustion on the fifth day. There could be no doubt that the torsion had existed for a very long time, and that the peritoneal infection was also of considerable duration.

Notwithstanding these difficulties, **the knowledge of the existence of a tumour** is an extremely valuable diagnostic point: (1) When it has been discovered and *definitely recognized previously*, it permits of an almost certain diagnosis. (2) When the patient is seen in the initial stages of the acute attack, and it is possible to determine by successive examinations that *the tumour has rapidly increased in size* during the hours or days immediately following, the fact is of very great importance. (3) The single fact of the existence of a definite tumour at some part of the abdomen, together with the acute symptoms which we have described above, is practically sufficient to put an end to all uncertainty; there is in it a physical basis for the functional reactions; this may not be sufficient to determine its true character, but ordinary common sense would demand an immediate exploration.

We have already said that it is necessary to include **sudden torsion of the pedicle of a movable spleen** in the group of abdominal accidents which we have under consideration.

The clinical picture closely resembles that we have just studied; the initial appearances are almost invariably those of peritonitis. One of Hartmann's cases[1] will supply us with a good example.

"A girl, 18 years of age, who, apart from intermittent fever and the presence of a large, tender spleen, had always enjoyed good health, was on March 26th, 1893, two hours after breakfast, suddenly seized with abdominal pains accompanied with vomiting; she felt so ill that she could not walk any further, and therefore went into a chemist's shop. From there she was taken home, and continued to vomit during the two following days. After a temporary remission, the symptoms reappeared in an aggravated form, and the patient was admitted to the Hospital Bichat on April 8th with symptoms of peritonitis.

"The face is pale, the eyes sunken, the pulse feeble and 120 per minute; the temperature, however, remains normal. The abdomen is distended, tense, and sensitive to the slightest pressure. The percussion note is everywhere dull except in the hypogastric region, hypochondria, left flank, and the most posterior part of the iliac fossa. A median incision exhibited, through the reddish, thickened, and slightly adherent omentum, a brown subjacent mass. On raising the omentum, some 10 or 12 ounces of yellowish fluid mixed with flakes of fibrinous lymph escaped, and we saw the spleen, of enormous size, presenting by its convex surface, which instead of being external had become internal. We drew it outside the wound, separating the reddened loops of small intestine from its deep surface, to which they were glued by the fibrinous exudation. We thus reached *the pedicle, which was of the thickness of the umbilical cord, and twisted twice*

[1] Hartmann, "Note sur quatre cas de rate mobile." *Comptes rendus du Congrès français de chirurgie*, 1895, obs. i., p. 499. See also in this article a reference to a series of other similar cases; in almost all, the symptoms of peritonitis have disappeared abruptly after removal of the spleen, without lavage or drainage of the peritoneum. The condition is, in fact, according to Hartmann, one of *aseptic peritonitis*. (See Hartmann and Morax, "Note sur la péritonite aigue généralisée aseptique." *Ann. de gynécol.* 1894, t. i., p. 103.)

on itself, in the direction of the hands of a watch. We untwisted it, then tied it with a double interlocking silk ligature, and applied over all a security ligature. The vessels in the pedicle were thrombosed. The damaged omentum was resected." The patient recovered, and remained well two and a half years later.

Here again, it will comparatively rarely happen that attention has not been previously drawn to the spleen; even during the height of an acute attack, the extent of the dullness and the size and situation of the tumour will at least furnish sufficient indications of the need for operation and of the probable nature of the condition.

Lastly, let us mention **the torsions of the great omentum**, which usually occur in association with omental herniæ, but which may also, the hernia being reduced, assume all the characters of purely abdominal lesions.

Case 69.—I have seen a very striking example[1] in a wine-seller, 44 years of age, who had been seized, four days before, with sudden pain in the right iliac region; the abdomen was distended; there was vomiting of greenish material; a temperature of 101°; the pulse was 100, and strong. A doughy, tender mass could be felt in the right iliac fossa; it was of considerable size, but the outline was very ill-defined on the inner side, and it gave the impression of being a very large appendicular swelling. On the right side there was also an inguinal rupture of very old standing, which had never given any serious trouble. At the time of examination the sac was empty, and the finger could be easily introduced through the wide internal ring.

I made an oblique iliac incision, which at once exposed a large mass of adherent omentum; this mass I liberated and raised from without inwards; it covered no inflammatory focus; it was thick, dense, blackish, and ecchymotic in places; it gave the sensation of a nodular tumour, and extended very far upwards. The incision was enlarged longitudinally up to the false ribs; it then became possible to separate and bring the whole mass outside. This consisted entirely of great omentum; above, it was attached to the transverse colon by a pedicle as thick as the two thumbs, about 2 inches in length, hard, fibrous, discoloured, and *twisted on itself a great number of times.* The twisting was very tight, and the turns lay close together; it was difficult to determine the exact direction of the twist, but it seemed to be from right to left. The pedicle was secured with chain ligatures of thick catgut, at a distance of an inch from the transverse colon; it was then divided, and the whole enormous mass of omentum removed. The appendix was not at all adherent, and bore no traces of recent inflammation; however, as it seemed to be rather large and thickened, I resected it; then, in order to avoid prolonging the operation, I contented myself with closing the internal orifice of the hernial sac with a catgut suture. The two first days passed without any incident; but on the evening of the second, the patient, who was an inveterate drinker, suddenly developed very severe delirium tremens and died during the night.

In a second and more recent case I was able to make the diagnosis before operating.

Case 70.—The patient was a man of 37 years, who had also been sent to me for "appendicitis," with symptoms of eleven days' duration. In the right iliac fossa and flank I felt a very large ovoid mass, fairly well

[1] This case is published in Georges Brunet's thesis, *Essai sur une forme spéciale d'épiploïte chronique et sur la torsion de l'épiploon.* Paris, 1900, p. 59, obs. iii.

limited on the inner side, but without a definite border; it was very slightly movable, doughy, thick, and painful on palpation; below, it was connected by a thick cord with the contents of a right inguinal hernia (*Fig.* 447), the hernial contents were thick and firm, irreducible, crepitated a little under the fingers, and were not tender. This hernia had been present for seventeen years; it had become irreducible at the time of the onset of the symptoms, which had, however, considerably improved since; there was no longer any nausea; the action of the bowels was regular; the pulse normal; while the temperature ranged from 99° to 100·5°. I therefore did not think I had to do with a large inflammatory mass of appendicular origin; and, on the other hand, the continuity of the abdominal tumour with the irreducible hernia led me to infer that the condition was an *omento-volvulus*.

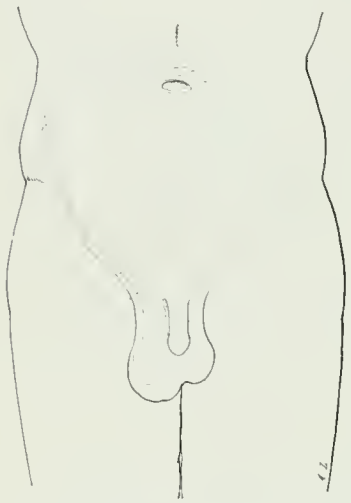


Fig. 447.—Torsion of the omentum. Outline of the abdomino-scrotal mass.

This diagnosis was verified at the operation; I incised the inguinal canal longitudinally and found a distended and compact hernial sac; I prolonged the incision on to the outer border of the rectus muscle; after dividing the musculo-aponeurotic wall, I opened the peritoneum through a small fold raised just above Poupart's ligament, and began the separation of the adhesions between the omentum and the serous membrane, incising the latter downwards to the bottom of the hernial sac as I advanced, transversely to the limit of the parietal wound; I succeeded in this manner in freeing the omental tumour from below upwards; I reached the pedicle just below the transverse colon, twisted three times at least on itself, and of the thickness of the thumb; it was easily untwisted, secured with two interlocking catgut ligatures, and divided. The appendix, which was adherent to the omental mass and otherwise practically healthy, was removed; the hernial sac was resected, and the parietal wound closed. Simple recovery followed.

The tumour (*Fig.* 448) was the size of two fists, infiltrated with blood, and streaked with black-thrombosed veins.

Torsions of the great omentum are not very uncommon,[1] and must therefore always be kept in mind; three varieties may be distinguished: (1) *Omental torsion combined with an irreducible hernia*; (2) *Torsion combined with an empty hernial sac*; (3) *Torsion without any hernia.*

The last type, the omento-volvulus, exclusively abdominal, and without any indicating hernia, is much the most uncommon and the most difficult to recognize; however, the rapid development, the size, and peculiar consistence of the tumour, and relative mildness of the symptoms may render correct diagnosis possible, and will at least prevent confusing it with a large appendicular abscess when the mass occupies the right iliac fossa.

[1] I have been able to collect 66 cases. (La torsion du grand épiploon. *Semaine médicale*, 13 février, 1907, p. 73.)

It is indeed with appendicitis that omental torsion has most often been confused. The co-existence of an irreducible omental hernia, or even the presence of an empty hernial sac on the same side as the abdominal tumour, constitutes a valuable diagnostic point. Further, the omental "tumour" does not completely resemble an appendicular swelling; it is more elongated, and is situated farther inwards; it does not extend to the lateral border of the true pelvis, and one can usually find a depressible and resonant area to its outer side; although the outlines are ill-defined and it is adherent, it can be grasped as a whole and moved a little from side to side; lastly, it is ordinarily of considerable size (as large as the head or two fists), and the hypothesis of an appendicular abscess of such size would scarcely agree with the mildness of the symptoms and their recent origin; here, as in all torsions, the fever is not very high, rarely exceeding 100°–101°, and the peritoneal reactions are comparatively mild.

Fig. 448.—Torsion of the great omentum.

Gangrene is, however, always to be feared, and operation is essential. If there is a hernia, the incision will be made over it, and then prolonged on to the abdomen along the outer border of the rectus; one must also remember the relatively frequent occurrence of a double torsion in these cases, one at the level of, or a little above, the neck of the sac, the other subcolic, at the upper attachment of the omentum (*Fig.* 449), and the incision must always be enlarged sufficiently to allow of the upper part of the omentum being brought into view. In cases of intra-abdominal torsion, the mass will be gradually liberated and resected after the application of interlocking ligatures to the pedicle, which should be untwisted if possible before being ligated.

In all acute torsions, laparotomy is necessary at a more or less early stage, according to the nature and gravity of the symptoms; but here we may repeat the formula, the truth of which has so often been demonstrated in urgent surgery: **one will never regret having operated too soon, and the extent of the lesions which will be found when the abdomen is opened will always exceed expectations.**

Technique of Operation.—Often in these conditions the operation will primarily be an exploratory laparotomy; the diagnosis is not assured; a tumour has been felt with regard to the nature of which no definite

conclusions can be formed ; it will therefore be necessary to proceed with great caution. When the abdomen is opened, go immediately to the region where the tumour has been perceived ; remember that almost always it will be enveloped with adherent loops of intestine ; the adhesions are usually soft, but they ought nevertheless to be separated gently and methodically ; the tumour or cyst may perhaps be full of pus, its wall may be gangrenous and friable, and the least rough handling might rupture it and flood the peritoneum with septic fluid.

Expose the mass, step by step, protecting the surrounding intestines with compresses as the work advances ; do not expect to be able to make the diagnosis forthwith as soon as the mass becomes visible. Undoubtedly, if it is a large cyst, when properly isolated it will be recognized without trouble in spite of its colour and superficial appearance ; but if it is small or even of moderate size, as, for instance, a pedunculated fibroid or a hydrosalpinx, attached to the uterine base by a long pedicle (*Fig.* 450), surrounded and masked by the neighbouring loops, only *a reddish or blackish tumour, resembling the dilated cæcum or a twisted loop of small intestine will at first be seen, and its singular appearance will at first be very disconcerting.*

Fig. 449.—Double torsion of the great omentum, subcolic and inguinal. (Diagrammatic).

To settle any doubts, try to separate the entire surface of the mass, and this will inevitably reveal a narrowed part springing from the main mass, which when followed and separated will give the key to the situation. Always endeavour not only to isolate the tumour but also to bring it outside the abdomen, by raising it up between the two hands without any undue traction. Some twisted tumours cannot be mobilized in this manner, but remain firmly fixed in the depths of the cavity ; in such cases, untwisting the pedicle when it is practicable constitutes the only means of extracting them from the abdomen.

If the tumour is extensive or in any degree fixed, the best plan is to puncture it, after having taken the necessary precautions for the protection of the intestines ; almost invariably some blood, and often pus, will be withdrawn. Lastly, do not hesitate to enlarge the abdominal wound sufficiently for *working with ease*, which is equivalent to saying *with safety*.

When the tumour has been duly recognized and drawn outside the abdomen, it must be removed. This is usually quite simple in cases of

ovarian cyst or pedunculated uterine fibroids ; the pedicle, which is always comparatively small, is tied close to the uterine cornu or its attachment, divided, and cauterized with the thermocautery. The same measures apply to tubo-ovarian tumours. In the case of a twisted fibroid, associated with a fibromatous uterus (*Fig.* 451) hysterectomy is indicated.

The non-pedunculated uterine fibroids may cause **another variety of torsion which affects the uterus itself**: the tumour, implanted with a broad base near to the uterine fundus, involves the organ in the turning movement, and converts it into a sort of pedicle.

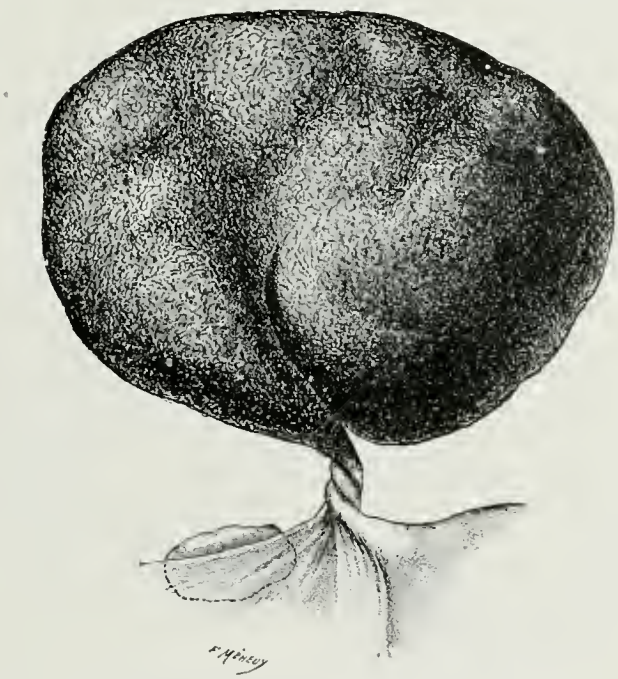


Fig. 450.—Hydrosalpinx with twisted pedicle. (Legueu.)

Axial uterine torsions may also be associated with solid or cystic ovarian tumours ;[1] the twist is usually situated near to the isthmus, which is thinned, drawn-out, and forms the pedicle. They are sometimes found during the course of operations for the removal of uterine fibroids or ovarian cysts ; they are then most often of long duration ; during an operation for fibroids, we have seen an infiltrated and œdematous tumour at the fundus of the uterus, which was twisted on itself through an arc of 180°.

[1] Out of 50 cases analysed by M. Barozzi, in 22 the axial torsion of the uterus was due to the presence of an ovarian tumour, and in 28 to a fibroid. ("De la torsion axiale de l'utérus." *La Gynécologie*, déc., 1904, p. 481.)

It is necessary to be aware of this possibility, because the appearance of such a twisted mass occasions a good deal of astonishment when first seen.

But the uterine torsion may express itself primarily by symptoms so acute as to necessitate an immediate operation, without as a general rule permitting the forming of a definite diagnosis; the condition is only recognized when the abdomen has been opened, and it is a debatable point as to the correct line of treatment then to be followed. The following case of R. von Holst[1] will serve as an example: on opening the abdomen

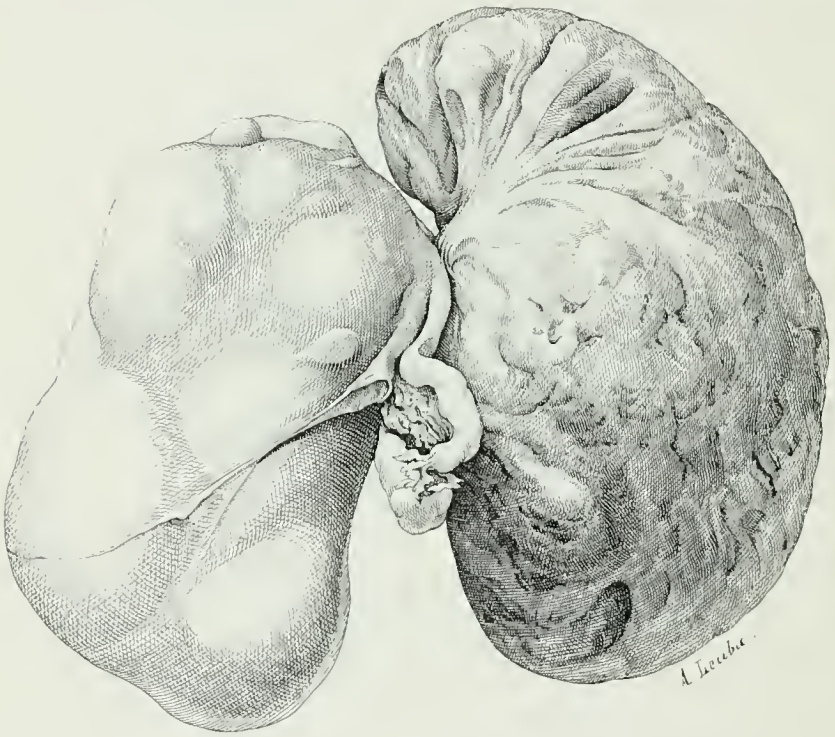


Fig. 451.—Uterine fibroid with twisted pedicle; fibromatous uterus.

through the linea alba, a quantity of blood-stained ascitic fluid escaped and the tumour presented itself, blackish in colour and pseudo-fluctuant in consistence. The peritoneum in the whole of the lower abdominal zone was deeply congested and felt slightly rough, but there were no adhesions to the tumour. After the mass had been drawn outside, its relationships with the uterus were easily made out. It was a very vascular fibroid, larger than a child's head, with a broad base on the fundus of the uterus; *it was twisted on itself in such a way that the right appendages had come to be*

[1] R. von Holst. "Ein Fall von Torsion eines subserösen Myoms. Myomotomie. Heilung." *Centr. f. Gynæk.*, 1894, No. 40, p. 967.

placed on the left side in front and the left appendages on the right side, near to the sacral promontory; the torsion was about 120°.

The torsion had caused a considerable degree of vascular stasis in the tumour, and also a peritoneal exudation. The fibroid, which was implanted in the enlarged fundus of the uterus, had grown into the left broad ligament and had pushed the corresponding tube and ovary upwards. After the application of a rubber band, the tumour was enucleated, the left appendages being preserved. The cavity which it had occupied was then closed with a series of silk sutures; then the uterus, which showed a tendency to become twisted again, was fixed to the abdominal wall. Conservative measures are undoubtedly to be preferred, particularly when the patient is young, or in the event of the uterus being gravid;[1] they will also be often applicable in the case of ovarian tumours; under any circumstances the first step ought always to be the removal of the tumour; when that has been done, if the uterus can be untwisted, and is not too much infiltrated, if the lesions at the isthmus are not too serious, then nothing more is required.

In the case of a fibroid, the enucleation of the tumour, when it is single, encapsulated, and easily separable, should be as a rule the first step; it permits the uterus to be untwisted and properly examined; if the organ is but comparatively little drawn out, it should be preserved, the intra-parietal cavity left by the removal of the myoma being closed by suturing its wall (see *Figs.* 456 and 457).

It is a different matter, however, in the case of a large fibroid tumour, with a very broad base, surrounded by other myomatous nodules, when the uterus is œdematous, congested, infiltrated with blood, and the isthmus partly divided or of doubtful vitality; or again, when the appendages are diseased; under such circumstances it will be necessary to perform **hysterectomy, supra-vaginal or total.** That is indeed, it must be admitted, the procedure most often required.

The removal of the organ is also the best treatment when dealing with **torsion of the splenic pedicle.**

Once exposed, the spleen is drawn outside the abdomen, the pedicle untwisted and tied by two interlocking ligatures, which it will be well to support by an over-all security ligature or by separate ligatures of the cut vessels in the face of the stump. As Hartmann has pointed out, splenectomy, when performed for a movable spleen, is greatly facilitated by the mobility of the organ and the absence of adhesions; all that is necessary is an incision sufficient to allow the organ to be drawn outside the abdomen, so as to bring the pedicle perfectly under control.

The prognosis of splenectomy for movable spleen is also very much better than that of splenectomy in cases of malarial or leukæmic enlargement; out of 48 cases collected by Hartmann of splenectomy for movable

[1] In a case reported by Lohlein, there was a large cyst of the left ovary, and a torsion through 140° of a gravid uterus (at the end of the 5th month); the cyst was removed and the uterus untwisted; the pregnancy went to term. (*Gynækolog. Tagesfragen*, 1895, No. 4, p. 8).

spleen, the mortality was 6·2 per cent, while in malarial hypertrophy it is 58 per cent. and in leukæmia 100 per cent.[1]

After any of these operations, dry cleansing of the peritoneum with gauze swabs or aseptic compresses is usually sufficient. Indeed, if the operation is performed early, the peritoneal exudation which is found does not appear to be of a septic nature, as has been demonstrated by the investigations of Hartmann and Morax.[2] At a later stage, naturally, if the affected organ is gangrenous or has ruptured, if diffuse peritonitis with turbid purulent exudation is present, peritoneal irrigation may be useful. The question of drainage will also depend on the nature and duration of the peritoneal lesions; it is well to say, however, that if the slightest doubt exists the wisest plan is to drain.

RUPTURES OF EXTRA-UTERINE GESTATIONS.

A young woman, 26 years of age, who had been suffering a little pain for a week, was suddenly seized on January 31st, 1897, about 6 o'clock in the evening, with an intense pain in the abdomen; she collapsed, partly lost consciousness, and only revived very incompletely, notwithstanding all the attention which was given her, and some hours later she was brought to the Hospital Beaujon, where I saw her.

She was very pale, her pupils were dilated, her expression vague, and respiration laboured; she answered questions badly, it being necessary to repeat them several times before her attention could be attracted; the depression was very marked, and appeared to become more and more accentuated; the pulse was very fast—130 to 135—and feeble, the extremities were cold, as were also the nose and the tongue. A subcutaneous injection of salt solution, which had been given on her admission, had appeared to cause some improvement in the pulse, but this had been only very temporary, not lasting more than a quarter of an hour.

The abdomen was large but not tense; it was dull only in the most dependent parts, the iliac fossæ and the hypogastrium; in the latter region it was possible to recognize by palpation, though not very definitely, a mass which seemed to reach to about 2 inches above the pubic symphysis and extend outwards towards the left; it was absolutely impossible to define the exact outlines, the consistence, or superficial characters of the mass; it was simply possible to determine its existence, nothing more. On vaginal examination the cervix was found to be softened and partially open, and the uterus enlarged, but exploration of the fornices gave no information. However, these various signs, together with the absence of menstruation for three months, or at least the substitution of very irregular discharges for the previously normal menstrual periods, and finally the very sudden onset of the attack, with the evident signs of serious internal hæmorrhage,

[1] Hartmann, *loc. cit.*, p. 504.
[2] *Loc. cit.*

constituted quite sufficient evidence on which to base a diagnosis of **rupture of an extra-uterine pregnancy.**

There was manifestly no time to lose; the simple fact of continued and dangerous internal hæmorrhage in itself demanded immediate operation.

I performed median laparotomy under superficial ether anæsthesia, while saline solution was administered continuously into the subcutaneous tissue of the arm. The peritoneum was blackish in colour; as soon as it was opened, a stream of red blood mixed with clots escaped, *and I found the whole abdomen full of blood.* I plunged my hand at once into the pelvis behind the uterus, and felt on the left side a thick mass which I raised and drew outside the wound; *it was the distended and ruptured left tube, and the rupture was still bleeding profusely.* Two clamps were applied, one close to the uterine cornu, the other on the outer border of the broad ligament, and the tumour was cut away. The two pedicles were at once ligatured with silk and cauterized.

I then devoted my attention to clearing the abdominal cavity; I evacuated several handfuls of clots, and sponged up the fluid blood as well as possible with aseptic compresses. A Mickulicz tampon was placed in Douglas' pouch,[1] and the wound partly closed. Two pints of saline solution had been injected during the operation; an hour later another pint was given. The patient rallied without very great difficulty, and next morning the pulse, though still fast, had become fairly good, and all immediate danger seemed to have passed.

I have seldom seen so large a hæmorrhage; in the face of such floodings it is astonishing that the patient still lives. One does not wait before seeking and tying a large artery which is bleeding at the bottom of a wound, neither should one wait before checking an equally dangerous hæmorrhage which is going on into the free peritoneal cavity. The indications are indisputable, and any one who has witnessed one of these "cataclysmic" ruptures will need no further argument in favour of operation, but will concentrate his attention on the best practical means of **obtaining hæmostasis forthwith.** We shall return to this important point immediately.[2]

In other cases, though primarily less violent, the tubal hæmorrhage, *by its persistence or recurrence,* produces an equally urgent situation after the lapse of a very short time. The first attack has passed, spontaneous hæmostasis appears to have occurred, and the patient has improved considerably, when suddenly the whole scene is reproduced. Here is an example.

Case 71.—A woman, 37 years of age, began to suffer with pains in the abdomen about the middle of December, 1897. On the 28th she was suddenly taken with an acute pain in the left iliac fossa, accompanied by pallor, coldness, and a sense of impending death. The condition of syncope lasted for several

[1] This occurred in 1897: nowadays we should either not drain at all, or drain with a tube.

[2] See the discussion of the question in P. Segond's paper, "Traitement des grossesses extra-utérines." *Congrès de Gynécologie.* Marseille, 1898.

hours; then the initial symptoms appeared to improve, but left behind a diffuse and well-marked sensitiveness of the abdomen, and a degree of weakness which compelled the patient to keep her bed.

Some days later she was admitted to hospital, where the diagnosis of ruptured extra-uterine pregnancy was easily made: the cervix was softened in the left fornix, and in front a large tender mass, which seemed to extend into the iliac fossa, could be felt; the abdomen was full, doughy, particularly in the subumbilical zone, sensitive to the slightest pressure, and very difficult to palpate.

Two days after admission, and shortly after the morning visit, the patient *suddenly turned pale and fainted*: she was cold, pulseless, the pupils were dilated, and it was with the greatest difficulty she was brought round. Thanks, however, to injections of caffeine and saline solution, dry frictions, warm wrappings, and inhalations of oxygen, the crisis gradually subsided, the pulse became better, and the skin warm; finally, the immediate danger seemed to have been averted.

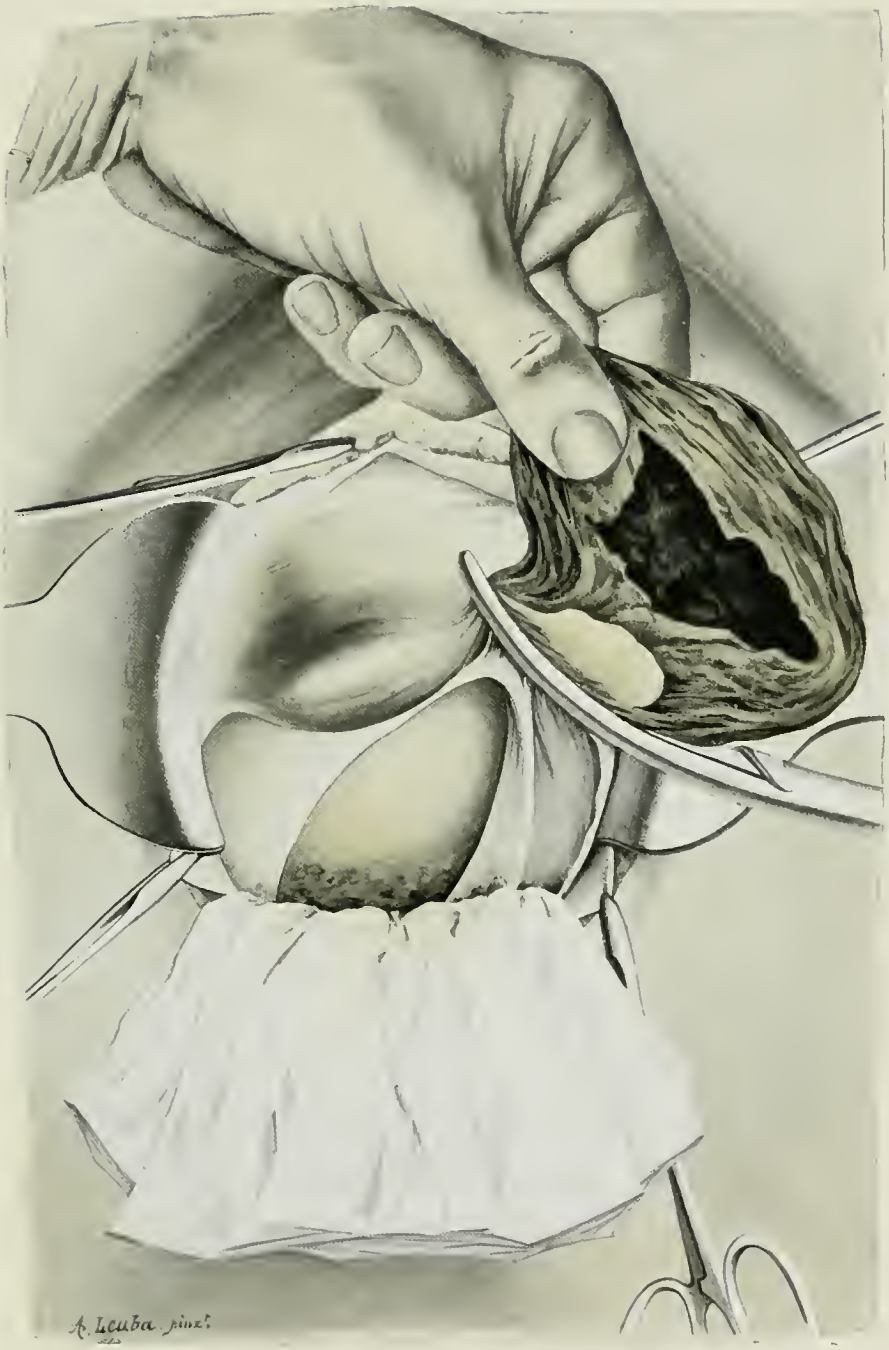
Laparotomy was performed: I found the omentum, blackish and infiltrated with blood, stretched in a continuous layer in front of the abdominal viscera, and pushed up, particularly on the left side, by an underlying fluctuating mass. While endeavouring to separate the omentum, the accumulation was opened, and an enormous rush of blood escaped, flooding the operation field, the surgeon, and the assistant; bright red blood was gushing from the left side of the bottom of the pelvis; I passed my hand in there, and rapidly extracted a fœtus about 4 inches in length, and a large mass of placenta; I then separated the tubal cyst, drew it outside the abdomen, and removed it, after clamping the broad ligament. The bleeding seemed to have ceased; I therefore cleansed and dried the enormous cavity with aseptic compresses, and packed it with gauze. The patient made an uncomplicated recovery.

Here, then, **the hæmorrhage had occurred in two stages**[1]; the apparent hæmostasis had been only a delusion, for the ruptured tube had continued to bleed, and though some adhesions had to a certain extent controlled the diffusion, the patient had nevertheless remained in constant danger of death from hæmorrhage. Under such circumstances, though the indications do not present themselves with the same characters of immediate urgency as in the foregoing type, they are not less pressing, and operation is imperative.

Another eventuality and another example. The rupture has occurred some days before; it has been followed by a considerable effusion of blood, accompanied by the ordinary signs of internal hæmorrhage, but the immediate dangers have been averted.

Fever appears, however, and the temperature rises rapidly; the pulse fails, vomiting occurs, the abdomen becomes more and more distended and tense; the intra-abdominal accumulation, which, owing to its primary encystment, had been perceived more or less definitely, undergoes a sudden increase; in short, infection has occurred, and the need for immediate

[1] Another case, a woman 35 years of age; operation on March 30th, 1901; the onset had been sudden, with a serious syncopal attack followed by improvement, and the pulse recovered its strength; 48 hours later there was a second seizure, with pallor, feeble pulse, and considerable abdominal distention. Laparotomy: the peritoneum was found literally full of blood; it was hastily emptied, and the right appendages were easily drawn out; they consisted of a cystic ovary and a tube about three weeks gravid, ruptured in its inner third. Removal. Recovery without incident. ("Les Hémorragies par rupture de la trompe gravide." *Gaz. des hôp.*, 16 janvier, 1902, No. 6, p. 49.)



RUPTURED TUBAL GESTATION

operation, though perhaps not of such vital importance as before, cannot be considered as otherwise than urgent.

Case 72.—A woman, 45 years of age, had felt a sharp pain in the right side, which had, however, only lasted a very short time; but a few days later it recurred with much greater severity, and radiated to the sub-umbilical region and into the loins, being associated with marked general depression, coldness, and abdominal distention. The initial symptoms subsided during the immediately following days, but soon fever appeared, the temperature rose to 102°, 103°, shivers occurred each day, the abdomen became more and more distended and universally sensitive, and there was repeated bilious vomiting. She was admitted to hospital in this condition. On examination *a huge mass was discovered, filling up nearly the whole of the abdomen*, extending upwards to about three fingers' breadth above the umbilicus, and outwards to either side, particularly the right. The outlines of the mass were very vaguely defined; it was dull, doubtfully fluctuant, and very tender; it could not be felt on vaginal examination.

Laparotomy was performed: immediately below and adherent to the parietal peritoneum, a blackish-coloured false membranous layer was exposed, bulging forwards under the pressure of the subjacent accumulation; it was incised, and after the opening had been extended to the limits of the parietal wound, *a large quantity of black clot and fœtid, grumous, tarry blood escaped*; the cavity extended well above the umbilicus and downwards to the bottom of Douglas' pouch, on the left side of which a thick mass was felt, embedded in adhesions and clots which it did not appear wise to attempt to remove. The symptoms subsided at once after the operation, and recovery was complete at the end of six weeks.

Delayed indications undoubtedly present themselves under characters quite different from those associated with the definite immediate indications based on the signs of diffuse hæmorrhage into the free peritoneal cavity; still they are of very decided importance, and in our opinion urgent surgical measures are required in three eventualities associated with rupture of extra-uterine gestations: (1) *In "cataclysmic" hæmorrhages*; (2) *In severe, repeated hæmorrhages*; (3) *In cases where infection of a large intra-peritoneal extravasation*, resulting from a preceding hæmorrhage, occurs. Later on, when discussing the subject of urgent colpotomy, we shall mention the indications to be met in cases of suppurating hæmatocele.

As we have already said, the question of operation in the "cataclysmic" hæmorrhages is scarcely open to discussion—at least when the accident assumes that dangerous form of which we have given an example. If the patient has been known beforehand; if she has been examined and kept under observation; if the existence of a developing extra-uterine gestation has been known or even suspected, the situation is very definite. I would also add that the mere possibility of such an accident throws a very considerable responsibility on the practitioner if he has not used his best endeavours to put Pinard's rule in practice: **before the fifth month, every diagnosed extra-uterine pregnancy demands surgical intervention.** But it must be admitted that diagnosis before rupture is not at all common, and very often the condition will present itself as a sudden, unexpected emergency, with little or no history and without any certain indications of its exact nature.

It has been said that in such cases it is always necessary to think of extra-uterine pregnancy, and indeed, tubal rupture ought to be included with ileus, peritonitis from perforation, torsion of pedicles, and perforative appendicitis in the list of abdominal accidents, of sudden onset and rapid evolution, which require immediate decision. That a diagnosis is often difficult and mistakes frequent no one will think of denying, and the most conscientious examination will often be powerless to avoid such mistakes; but practically all that is necessary is a diagnosis of the necessity for operation—in other words, a recognition of perfectly definite indications. And this is always possible.

I am only speaking of a diagnosis based on an adequate examination and positive reasons; urgent surgery needs other foundations than impressions and fears. Sudden pain, tendency to syncope, and peritoneal reaction characterize all tubal ruptures and sometimes assume, at least at the outset, a very alarming appearance, even when the hæmorrhage is in reality localized and insufficient to cause any vital danger.[1]

That is quite true; but in cases of acute anæmia the gravity of the symptoms is quite different, and above all *they are progressive*; the pulse, which becomes more and more feeble until it is uncountable; the pallor; the coldness, which extends from the extremities to the trunk; the collapse, which becomes more and more accentuated, constitute very definite signs; here again, as in so many other abdominal emergencies, **when in doubt, operate**, rather than assume the heavy responsibility of taking the chance of doubtful spontaneous hæmostasis.

Operation is always necessary in the "cataclysmic" ruptures, and if it is impossible to operate too soon on these cases, one may almost add that it is never too late.

That death may be inevitable after some tubal hæmorrhages no one can deny;[2] practically, however, if a decision is quickly made, and if all efforts are concentrated in carrying the task through as speedily as possible, they will usually be attended with success; there are numerous cases on record at the present day to prove the truth of this statement.

Immediate operation has given 84·7 per cent of recoveries, expectant measures 85·8 per cent of deaths;[3] such figures speak for themselves;

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[1] As, for instance, in the tubal abortions, without rupture, which are not at all uncommon. (See our article, *Semaine Méd.*, 23 nov., 1904.)

[2] This is particularly the case in the advanced periods of tubal pregnancy; in 56 cases of fatal ruptures, Maygrier found 9 immediate deaths (Maygrier, *Terminaison et traitement de la grossesse extra-utérine.* Thèse agrég., 1886).

A case published by H. Verneuil, of Brussels, may be quoted appropriately: he was about to operate for a right tubal pregnancy; during the preparation of the patient, the cyst ruptured: the abdomen was opened immediately, and although ten minutes had not elapsed from the moment at which the rupture occurred, the peritoneal cavity already contained nearly two pints of blood: the jet of blood which came from the laceration was comparable to that of an artery of large calibre. (H. Verneuil. "Grossesse extra-utérine. Rupture du kyste. Laparotomie." *La Clinique*, Bruxelles, 28 juillet, 1808, No. 30, p. 597.

[3] According to Cestan (*Des hémorragies intrapéritonéales et de l'hématocèle pelvienne.* Thèse de doct., 1894: *Revue générale, in Gaz. des hôp.*, 1894, No. 80, p. 801, and No. 82, p. 821) Choyau reported 30 cases in which waiting treatment was followed by death. (*Contribution a l'étude de l'inondation sanguine péritonéale par rupture de grossesse tubaire.* Thèse de doct., 1896.)

it will be well, therefore, not to be arrested by the threatening aspect which the patient so speedily presents, but go on and try boldly the last resource; very often, and in apparently the most hopeless conditions, it will mean safety and life.[1]

Technique of Operation. It is an exciting and dramatic operation, but in general presents no particular technical difficulties if the operator keeps his head and knows what to do.

No complicated equipment is necessary; the ordinary instruments used in any laparotomy—scalpel, pressure-forceps, scissors, needles, some clamps, curved and straight (*Fig.* 453)—suffice. The inclined position is useful,[2] and if no special operating-table is available, the position can always be improvised in some fashion, as we have indicated elsewhere.

The anæsthetic will be very cautiously administered; it may be omitted altogether if necessary. Before the operation, it will be well to give a subcutaneous injection of salt solution (or intravenously if the need is great), and to continue the injection to the end; this is an excellent practice in all extremely urgent operations, in which the operative shock and the anæsthetic may in themselves be sufficient to precipitate a fatal issue.

Never omit the proper preparation and the customary aseptic precautions; it serves no good purpose to check the bleeding if the patient dies some days later of infection, and blood contained in the peritoneum constitutes an excellent culture medium.

Make a **median subumbilical incision**; go down quickly to the peritoneum, which appears blackish and more or less bulging owing to the presence of the underlying blood; open it cautiously at the middle of the wound with the scissors, through a raised-up fold; *beware of the bladder*: remember that it is often pushed up far beyond the symphysis by the effused blood, and closely applied to the deep surface of the wall; it has repeatedly been opened. However, even if the accident should occur, there is nothing in it to cause great alarm, the important thing is to detect it in time, before having caused any extensive injury; the opening will be sutured and the operation continued.

The peritoneum is opened into and the blood begins to escape; complete the incision upwards and downwards on the finger. The abdomen

[1] One example out of many, since tubal rupture is common, and recovery also, by immediate operation. Patient, 35 years of age; in March, 1903, she was brought into our hospital service with all the signs of a "cataclysmic" hæmorrhage. We operated forthwith: the abdomen was full of blood and the left tube was ruptured; she recovered. Three months later she was brought in again one morning: the same clinical picture: extreme pallor, pulse feeble and uncountable, extremities cold and livid, abdomen distended and tender, general appearance very bad: the symptoms had come on suddenly the night before, ten days after a missed period. Laparotomy: the intra-abdominal hæmorrhage was just as great as on the previous occasion: the right tube had burst in its inner third: I found a fœtus of about a month amongst the clots. Recovery. These recurrences of tubal pregnancies are not very uncommon.

[2] With the reservation that the inclination is not too great and, more particularly, that the patient is only inclined after the greater part of the effused blood has been evacuated; otherwise the blood runs upwards and accumulates under the diaphragm at the bottom of the hypochondria, and consequently the final cleansing is rendered difficult and will probably be incomplete.

is opened, but the blood which flows from all sides masks everything. Do not waste time in sponging it up; turn the clots out of the abdomen in handfuls, and immediately **plunge the hand into the pelvis behind the uterus,** which is always recognizable. The source of the bleeding is there, behind the uterus: to the right or the left you feel the thick, soft, friable mass of the ruptured tubal cyst; enucleate the whole mass with the fingers out of the pouch of Douglas, from below upwards, bring it outside and immediately clamp the outer border of the broad ligament. (*Plate X.*)

If the tumour has a good long pedicle and can be brought well outside, a single long curved clamp, applied below it, will suffice to secure the broad ligament; more frequently, however, it will be necessary to use two clamps, applied obliquely, the one close to the uterine cornu, the other on the outer border of the ligament.

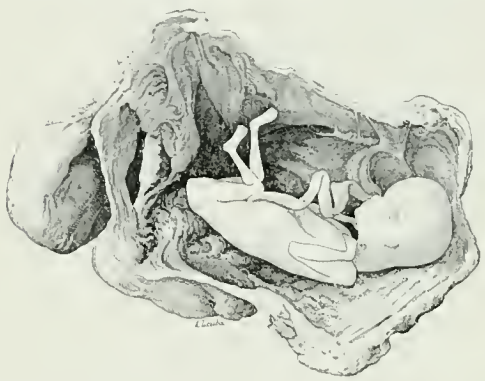

Fig. 452.—Sac of a tubal gestation.

That is the chief step of the operation; when it is achieved, hæmostasis is assured; it only remains to remove the mass (*Fig.* 452) and to replace the clamps by ligatures. Any other attempt at hæmostasis, any partial clamping, any blind compression, will only result in loss of time and blood; **the bleeding can only be controlled by the entire removal of the appendages and complete clamping of the broad ligament.** Apply the ligatures at once; if only a single clamp has been used, it will be replaced by a double interlocking ligature or Lawson Tait's ligature; remember that in these cases the broad ligament is often friable and cuts easily; to avoid that accident, *place the ligatures at a sufficient distance from the clamps*, so that the tissues may have sufficent play to allow themselves to be drawn together by the thread without tearing.

When two clamps have been used, the two portions of the broad ligament will be ligatured separately, and the two stumps should be firmly united by tying the two pairs of ends of the two ligatures together; if a small bridge of the ligament remains not included between the tips of the clamps, this precaution is all the more necessary. If required, and if any oozing still persists, the two stumps should be approximated, and the intermediate bridge of ligament secured, lifted up with forceps, and a security ligature applied around the whole pedicle below the two primary

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Plate X. **Rupture of a tubal pregnancy.** The ruptured fœtal sac has been extracted, and the broad ligament secured with a clamp. (The patient is in the middle inclined position.)

ligatures. *It is impossible to devote too much care to securing the pedicle*, but there is no need to exaggerate the difficulties of a task which simply requires to be performed carefully and without precipitation.

If one has had some practice in pelvic operations, and can carry it out quickly, the best plan is as follows: After the tubal mass has been brought outside and raised well up, apply a pair of Kocher forceps to the

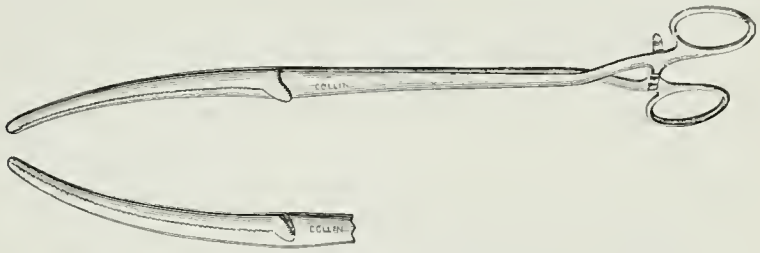

Fig. 453.—Strong curved clamps.

broad ligament from without inwards, and divide the ligament above the forceps with scissors; then apply a second pair of forceps to the inner portion of the ligament right up to the uterine cornu, but excluding the tube, and cut it in its turn (*Fig.* 454); divide the tube with the thermocautery at its origin, and carefully destroy the mucous membrane in the stump.

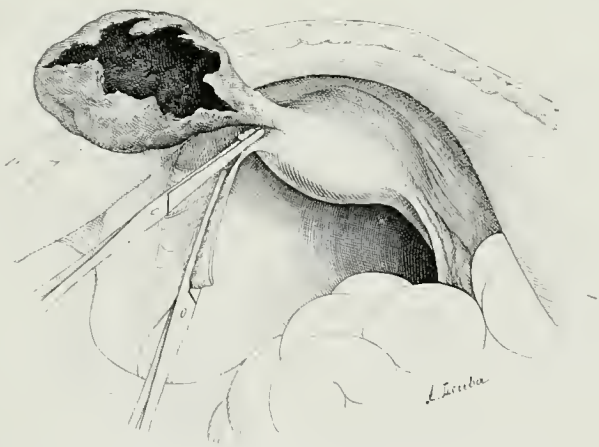

Fig. 454.—Removal of the appendages in a case of ruptured tubal pregnancy. Two pairs of Kocher forceps are applied to the broad ligament.

Now ligature the two pedicles, excising if necessary any redundant portions. At the uterine cornu, bury the little tubal stump by means of three interrupted Lembert sutures, and cover in the pedicles by means of a continuous suture of No. 0 catgut, bringing two peritoneal folds over them (*Fig.* 455). If the broad ligament is infiltrated and friable, it will be better not to

attempt the last-mentioned plan. Attention must now be devoted to cleansing the peritoneal cavity.[1] Sometimes, when the patient's condition is very bad, one may have to be content with incomplete evacuation of the extravasated blood, and terminate the operation as speedily as possible, leaving more or less blood in the abdomen. This is, however, simply a method of necessity; usually, with the assistance of continued infusion of salt solution, it is possible to carry out the operation in its entirety by carefully cleansing the intestinal loops, the omentum, the iliac fossæ, and Douglas' pouch with aseptic gauze swabs and compresses. If the cleansing has been satisfactorily performed, the abdomen should be closed completely; if, on the other hand, the cleansing has had to be curtailed, it will be advisable to *leave a drainage tube* in the abdomen.

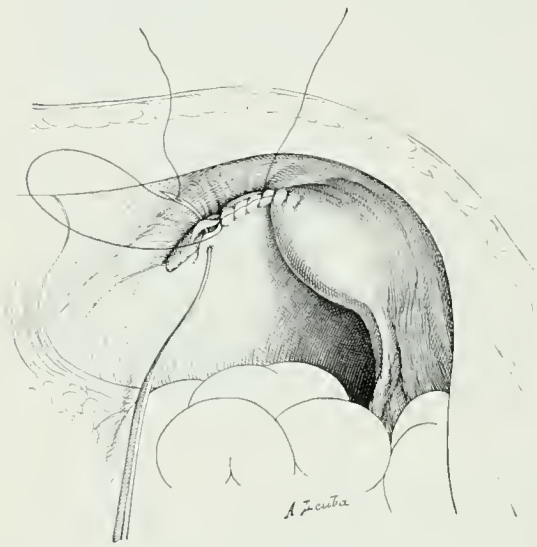

Fig. 455.—"Peritonization" after removal of the appendages.

The technique is somewhat more complicated in the case of a **tubo-interstitial pregnancy.**

When the fœtal cyst is of moderate size, and has only in part developed in the thickness of the uterine cornu, **extirpation, with excision of a wedge of uterine tissue and closure of the gap by suture,** is possible, and has given excellent results, as the following case shows.

Case 73.—A woman, 35 years of age, was brought into our hospital service, with abdominal symptoms indicative of a complicated tubal gestation. However, as the condition was not immediately urgent, and the diagnosis was rather obscure, it was decided to wait till next day. The situation had then altered decidedly for the worse: the pallor was extreme, the pulse very small, thready, almost uncountable, and respiration was laboured; the abdomen was distended, and tender over its whole surface: the signs of internal hæmorrhage were therefore only too evident.

I performed laparotomy at once, under careful ether anæsthesia, and with continued infusion of saline solution. An enormous quantity of blood and clots

[1] Do not neglect to examine the uterine appendages on the other side, as bilateral tubal pregnancy may occur. We have ourselves operated on one case, the tubal sac having ruptured on one side and being intact on the other; MM. Jayle and Mandrot have collected twenty-nine cases. ("La grossesse tubaire bilatérale." *Revue de Gynéc. et de Chir. abdom.*, 1904, t. viii., p. 195.)

escaped from the abdomen, and we immediately discovered on the right side a large blackish tumour, with a fissure in its upper part, from which blood was flowing profusely. After quickly emptying the pelvis and the iliac fossæ, the patient was placed in the inclined position, and the fœtal cyst could then be very clearly seen. It was of the size of a child's head : *it occupied the right uterine cornu and the inner third of the tube* ; to the outer side of the mass, the rest of the tube and the ampulla retained their normal appearance, as did also the ovary, which could be seen below ; the uterus was enlarged, but its right cornu was in itself twice as large as all the rest of the organ.

I opened the cyst and extracted a fœtus about 5 inches long ; then the broad ligament was clamped and divided to the outer side of the tube and ovary, and the section continued from without inwards below the tumour, forceps being placed on the vessels as they were divided ; the uterine cornu was cut out with the knife, a large wedge being excised, including the whole of the inner part of the fœtal cyst, which was thus completely removed. The vessels in the broad ligament were ligatured separately, the cut edges of the ligament being united by a continuous suture : the two surfaces of the gap in the uterus were brought together by a first, interstitial, continuous suture (*Fig.* 456) ; and the edges by a second, superficial, Lembert suture, also continuous (*Fig.* 457), and continuous with the suture in the margin of the broad ligament (*Fig.* 458). The appendages on the left side were healthy. A small drainage tube was placed in Douglas' pouch and the abdominal wound closed. The patient made a perfect recovery.

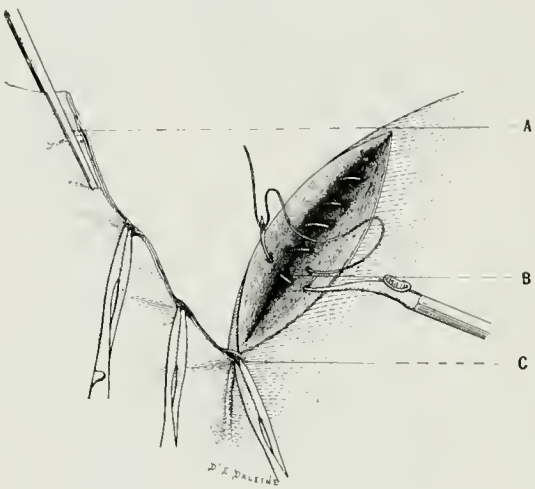

Fig. 456.—Ruptured tubo-interstitial gestation. The fœtal cyst has been extirpated after section of the broad ligament and resection of a wedge of the uterine cornu. Interstitial suture approximating the surfaces of the gap in the uterus. (A) Outer border of the broad ligament, compressed by Kocher forceps. (B) Interstitial continuous suture. (C) Uterine artery secured by forceps, as are also the other cut vessels in the broad ligament.

In other cases of this kind, the impossibility of forming a pedicle on the inner side, or the need for a very extensive resection of the uterine wall, may necessitate either total or supravaginal hysterectomy ; and following Segond's rule,[1] any interstitial gestation recognized by exploratory laparotomy ought to be removed immediately by abdominal hysterectomy, either total or supravaginal.

When the rupture has taken place at a more advanced stage, beyond the fifth month,[2] the operation is naturally very much more troublesome,

[1] *Loc. cit.*, p. 15.

[2] Late ruptures are, however, comparatively uncommon. In the cases in which the age of the pregnancy is mentioned in 422 cases of ruptures collected by Choyau (thesis already quoted), the rupture occurred 33 times in the 1st month, 99 times in the 2nd, 70 times in the 3rd, 19 times in the 4th, 8 times in the 5th, and once in the 6th month. See further, for the

and the extirpation of a large, adherent, friable sac, which tears and bleeds profusely on the slightest interference, may be associated with great difficulties and serious risks. As soon as the fœtus is extracted and the cord tied, the best plan is to try to marsupialize the sac without interfering with the placenta.

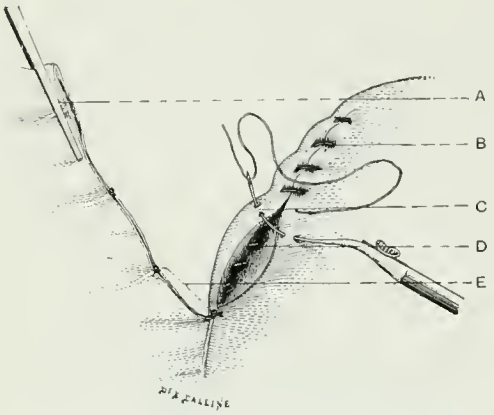

Fig. 457.—Ruptured tubo-interstitial gestation. Repairing the breach in the uterus; the superficial continuous suture. (A) Outer border of the broad ligament, secured by pressure forceps. (B) Closure of the uterine wound. (C) Superficial continuous suture introduced in Lembert fashion. (D) Interstitial suture. (E) Arteries in the broad ligament tied separately.

If, however, the placenta is already widely separated, the bleeding can only be checked if the organ is completely removed. The operator must give himself plenty of room, and immediately apply clamps on either side of the mass, one close to the cornu of the uterus, the other on the extreme outer part of the broad ligament, and then proceed with the enucleation of the fœtal cyst from without inwards, and from behind forwards.

Complete removal; hæmostasis by clamp and ligature in the whole area of pelvic attachment and at the vascular pedicles of the appendages: that is the absolutely essential programme.[1]

Here again abdominal hysterectomy will sometimes be required; it is the only treatment applicable to the interstitial gestations.

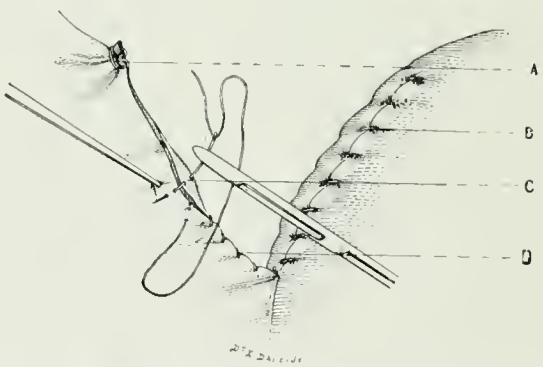

Fig. 458.—Ruptured tubo-interstitial gestation. Suturing the edges of the broad ligament. (A) Outer border of the broad ligament tied separately (ovarian vessels). (B) Uterine wound closed. (C) Continuous suture uniting the cut edges of the two layers of the broad ligament. (D) Inner border of the broad ligament, restored.

The same indications present themselves when operation is undertaken, not under the compulsion of signs of dangerous internal

very important question of the appropriate treatment of tubal pregnancies beyond the 5th month, the works of Prof. Pinard (*Documents pour servir à l'histoire de la grossesse utérine*, 1892, and *Bull. de l'Acad. de méd.*, 16 août, 1895), and also P. Segond's article (*loc. cit.*).

[1] For profuse and diffuse hæmorrhages, no dependence can be placed in gauze packing to obtain a satisfactory result, however tightly it may be done: it will always be inadequate and can give only very doubtful security.

hæmorrhage, but to put an end to lesser bleedings which recur at short intervals.

The extravasation is then not so great and the diffusion less extensive ; the hæmorrhage is, however, still progressing, and satisfactory results are only to be obtained by complete extirpation of the fœtal sac.

It is only in the third hypothesis which we have mentioned, when the indications for operation are furnished by the symptoms of infection of a large intra-peritoneal accumulation of blood and clot resulting from a rupture which is already of some standing, that *simple incision*. evacuation and cleansing of the infected focus, followed by drainage, can be considered as sufficient ; still, even under these conditions we must add, that the operation will be more complete, and the best results assured, if the remains of the ectopic gestation can be extirpated without injury to other parts.

END OF VOL. I.

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